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ABSTRACT

Every active family and business produces solid waste, some of which are the nonhazardous discards of society. Taken as individual substances, our newspapers, food leftovers, containers and wrappings, grass clippings and tree limbs seem harmless enough. But huge volumes of these materials are generated daily. It has been projected that many counties in Ohio may run out of approved landfill space by the end of this century. The purpose of this publication is to promote student research on litter prevention and recycling. This science workbook contains 26 student research project ideas submitted by business, industry, trade associations, and others. Also included are "The Solid Waste Crisis in Ohio"; "Background on Litter Prevention and Recycling"; and "How to Find Information on Litter Prevention and Recycling" (including information on using the library, reference books, journals, indices, abstracts, vertical file and letter writing). "References and Resources" include the addresses of 40 organizations and agencies, and a bibliography of over 200 references. (CW)

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Ohio Science Workbook:
LITTER PREVENTION & RECYCLING

1987 Edition

Edited by

Lynn Edward Elfner

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FOREWORD AND ACKNOWLEDGEMENTS

The purpose of this publication is to promote student research on litter prevention and recycling. The concept of a science workbook with student research project ideas submitted by business, industry, trade associations and others dates back to 1964 when The Ohio Academy of Science cooperated with the Ohio R & D Foundation in the production of the first workbook of ideas. Since then nearly 20 different workbooks have been produced.

This publication is the result of work by many people. I especially want to thank Ms. Mary Ward, Mr. George Peters, Jr. and Ms. Anne Filbert of the Office of Litter Prevention and Recycling for financial support. They also spent many hours reviewing drafts and providing background information.

Project ideas came from many sources including:

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Montgomery County Litter Prevention & Recycling Program
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Anheuser-Busch, Inc.
International Paper Company
Reynolds Metals Company
The Ohio Environmental Protection Agency
Richard D. Benz, Wickliffe High School
Firestone Central Research Laboratories
The Institute of Scrap Iron and Steel

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I also appreciate the interest and support of Ms. Diana L. Rogers, Education Specialist with the Columbus Clean Community, who submitted several projects originally submitted for her project workbook.

Lynn Edward Elfner

THE SOLID WASTE CRISIS IN OHIO

The following section is a reproduction of the text of a publication of The Ohio Alliance for the Environment, FOCUS on the Issue: Understanding Ohio's Solid Waste Crisis. The publication was based on a report prepared for the Alliance by Lynn Wasnak and was funded in part by contributions from the Columbus Audubon Society, the Ohio Conservation and Outdoor Education Association and Waste Management Inc.

UNDERSTANDING OHIO'S SOLID WASTE CRISIS

SOLID WASTE—BY-PRODUCTS OF LIVING

Every active family and business produces solid waste, the nonhazardous discards of society. Taken as individual substances, our newspapers, food leftovers, containers and wrappings, grass clippings and tree limbs seem harmless enough. But huge volumes of these materials are generated daily. According to the Ohio Environmental Protection Agency (EPA), Ohioans presently discard over 7 million tons of solid waste each year. The projected volume for 1990 is over 9 million tons. If the popularity of disposable products continues to rise, these amounts will increase indefinitely.

Where Ohio's Waste Goes

But while the generation of solid waste is rising dramatically, Ohio's capacity for disposal is shrinking. There are presently only five licensed incinerators and two trash burning power plants operating in the state.

The bulk of Ohio's solid waste is buried in sanitary landfills. The 644 licensed landfills operating in 1969 have dwindled to a mere 198 in 1986. And of those 198, 50 are on-site industrial facilities that accept only waste generated by company operations.

The Problem

With steadily increasing waste volume, and steadily diminishing waste disposal capacity, Ohio citizens face a serious dilemma. Forty-eight of 88 counties are expected to run out of approved landfill space by 1991. The public, concerned about the safety of landfills, is presently unwilling to permit the siting of new landfills and often opposes expansion of existing ones.

Ohio can learn an important lesson from its neighboring states. Costs of disposal in New Jersey and Pennsylvania have nearly tripled in the past five years. Some solid waste from these areas is actually being trucked to Ohio for disposal . . . a situation many Ohioans resent.

But at this time there is no statewide plan of action. There is not even a schedule that requires a plan to be made. Legislation intending to deal with the problem has made little headway in the Ohio House and Senate.

What will Ohioans do with this growing pile of garbage?

Education and Information

Until recently there was no coordinated effort between state and local governments and environmental, community and business groups to confront the pending crisis in solid waste management. But in November 1985 The Ohio Alliance for the Environment sponsored a two day conference in Columbus to bring all the concerned groups together. These sessions permitted a number of different viewpoints to be aired.

Subsequently, other forums have been held on a regional level in various parts of the state. These meetings, normally open to all interested parties, are designed to increase awareness of Ohio's solid waste problem. Experts pool information about the waste stream and existing disposal methods. The problems of siting new facilities as well as alternatives to traditional landfilling of solid wastes are discussed.

EFFECTIVE WASTE DISPOSAL—NO QUICK, CHEAP SOLUTIONS

There is no single solution to the solid waste problem in Ohio or anywhere else. There is no quick fix. Although solid waste can be disposed of safely, modern facilities are expensive to build and maintain.

Most experts agree that current waste disposal charges rarely reflect actual costs. Environmentalists and business people alike agree that someone must pay for the proper disposal of solid waste. They also agree that the federal government won't rescue the state. Ohio's problem must be solved here in Ohio.

Every disposal method has its trade-offs and inconveniences. We have yet to decide what mix of disposal methods is best for Ohio's population. No one knows who will ultimately decide the issues of siting. And though the public will pay for solid waste disposal, one way or another, the costs are not yet clear.

Waste Reduction

If we were able to reduce the amount of solid waste entering landfills, the landfills would last longer. Changes in packaging and buying habits plus increased recycling and composting (the recycling of organic wastes) could help reduce the flow of solid waste to disposal centers.

For example, manufacturers could design consumer packages with the goal of minimizing layers of paper, plastic and foil. Wherever possible, materials that disintegrate easily (biodegradable materials) could be used. The public could be encouraged to buy large bulk packages rather than small, minisize packages to reduce the amount of waste.

Some experts suggest that the cost of disposal should be added onto all consumer products, collected by manufacturers, and turned over to those responsible for disposal, to build and maintain facilities. However, business groups generally oppose this approach. They feel it unfairly turns the manufacturer or business into a tax collection agency and excessively drives up consumer costs.

There is also the problem of correctly estimating the actual cost of disposal of any given product. So far there is not much accurate information available on this subject.

Recycling

Recycling, or reusing discarded products or materials, seems to be a very sensible way to reduce the waste stream. Some experts estimate that under optimum conditions as much as 50 percent of the typical municipal waste stream could be recycled. Both glass and aluminum container manufacturers encourage recycling, since reusing these materials saves them money in processing and in the price of raw materials. Even some plastics such as milk jugs can be recycled efficiently.

Ohio supports an active recycling program, both through the efforts of the State Office of Litter Prevention and Recycling (OLPR), and a non-profit, industry-based group called the Ohio Business & Industry Recycling Program, Inc. (OBIRP).

Established by law in 1980, OLPR has been appropriated over $30 million for litter control and recycling programs during the past six years. In 1986 nearly 150 Ohio communities received grants for litter prevention and recycling. Programs supported by these grants included educational programs, public awareness, increased enforcement of litter laws, litter collection projects and household recycling opportunities. In addition to administering the grants programs, OLPR provides technical assistance to both grant and nongrant communities and coordinates statewide events.

The Ohio Business & Industry Recycling Program sponsors consumer-centered recycling of newspapers, aluminum, glass and other materials by for-profit and nonprofit recyclers. Multi-material recyclers who meet its standards are entitled to use the distinctive green and white logo and promotions of The Recycling Station.

In the first 18 months since The Recycling Station program began, some 30 multi-material recycling stations qualified for membership. About $6.5 million was paid out to the public for recycled materials.

But there are roadblocks to effective recycling that should be overcome. The first problem is collecting the material. If it is not convenient or cost-effective for the consumer to separate waste and turn it over to recyclers, everything will wind up in one garbage can.

Secondly, markets for recycled materials fluctuate. If a recycler collects a material, but then cannot resell it at a profitable rate . . . or, in some cases, can't even give the material away . . . it might just as well not be collected separately. To please the public, recycled materials must be stored in a nonoffensive way. That requires considerable space, especially if the recycler is waiting for prices to rise so resale is profitable.

Some groups have proposed curbside collection of separated recyclables. The householder would make separate garbage bags for papers, glass and metal, which would be picked up by the recycler. If householders found the separation process inconvenient, a financial incentive could be offered: those who separate their waste materials would pay less for disposal than those who lump it all together. But even then, there is the problem of how to prevent unauthorized pickup of the most valuable materials such as aluminum.

New Jersey and some other states rebate a portion of landfill disposal tipping fees to communities that support active recycling efforts. Whether they exist as profit-making or nonprofit entities, recycling centers benefit the community by removing material from the waste stream and reusing it.

Container Deposit Legislation—Pro & Con

At this time Ohio does not have a container deposit law. However, legislation has been proposed to charge a deposit on every beverage bottle and can sold in the state. The intent of this legislation is to encourage recycling and discourage littering at the same time.

Several consumer groups believe this type of legislation would help reduce the problem of solid waste disposal. They cite the experience of other states, notably Michigan, which has had a container deposit law in effect since 1978. Michigan's Resource Recovery Division estimates that 600,000 tons of containers have been removed from the solid waste stream annually, since the law went into effect. The containers are reused or recycled.

However, many businesses oppose this type of legislation. They argue that the volume of beverage containers is just a fraction of the waste stream. Even if all containers were recycled, the solid waste problem would hardly be touched.

Businesses also cite the hidden costs of container deposit legislation: more trucks, larger warehouse space and more employees are required to handle returned containers. Those costs are not covered by the small handling fees passed on in legislative rulings, they claim.

However, many businesses support The Recycling Station efforts. If Ohio's recycling program is given time to prove itself, they believe container deposit legislation may be unneeded.

Because present charges for waste removal are so low, it is difficult to get the public excited about recycling. This will change as the price tag for disposal rises in the next few years.

Composting

Composting is a sometimes controversial method of dealing with organic wastes. Ohio currently does not license composting facilities, although the method has been used on a small scale in backyards and residential communities.

Composting involves layering organic materials with dirt and permitting the material to return to earth or decompose. Grass clippings, ground-up tree limbs and some types of food leftovers can be used. Cities such as Columbus have mixed these materials with municipal sludge from sewage treatment plants, in a process called co-composting, to make a dry, fertile soil additive. The soil developed by composting is rich and nutrient laden, but its use is limited when substances such as pesticides or sludge containing heavy metals are introduced into the mixture.

Problems with composting are comparable to those affecting all basic recycling efforts: collection, separation and marketability. For example, the composted material prepared in Columbus is not recommended for use on food crops. Its part-sludge composition is

deemed safe only for flowers and lawns, thus limiting the market for this compost.

Incineration and Energy Recovery

Incineration is a disposal method that reduces the volume of solid waste. The ash that is left over after burning must be landfilled, or used in products such as roadsurfacing material. Thus incineration does not eliminate the need for landfills, but it greatly extends their life.

Papers, garbage and plastics release energy when burned. Heat recovery equipment, such as boilers and steam driven turbines, can be incorporated into incinerators to produce steam or electric power. These plants capture and distribute the energy resource that is usually untapped in solid waste. There are five licensed, waste-burning incinerators currently operating in Ohio, and two trash burning power plants.

Several types of incinerators and energy recovery systems are now available. Refuse-derived fuel (RDF) plants involve a preprocessing unit that grinds or chops the waste before feeding it into the burn units. Mass burn plants dump unprocessed waste directly into the burners. Either of these incinerator types can be fueled on a batch feed or continuous feed basis.

In earlier days, energy recovery plants were very expensive. Only the largest urban areas could afford them. Only a high waste-generating region produced enough burnable waste to keep the energy flow constant, and thus make the plant economically sound.

Some Ohio incinerators have had serious safety and maintenance problems. In the past, plants have been built for cities by contractors who simply handed over the keys, and the problems, to the city once the plant was built.

But today, smaller modular incinerators and energy recovery systems are being built, and developers and contractors are frequently tied into the long-term operation of the plant. That means any problems that crop up become the developer's or contractor's responsibility, not just that of the municipality or regional waste control district.

A state-of-the-art system of this type is planned for Marion, Ohio. In addition to waste energy recovery, this plant includes front-end waste separation, to remove materials for recycling. Innovative financing methods have been used to fund the Marion project, including state loans, federal grants, industrial revenue bonds, and private investment.

New businesses will locate there, says Marion's mayor Ronald Malone, to take advantage of low cost energy produced by the plant. If all goes well, the project is expected to bring up to 1000 jobs into the area. This particular project points out how waste disposal and resource recovery projects may benefit Ohio's employment picture, while preventing a solid waste crisis.

However, concerns about the safety of incineration have not disappeared. The greatest fears are of dioxin and furan emissions, and toxic ash. In Europe, municipal waste incineration has been targeted as the prime source of dioxin in the atmosphere. Many scientists feel that current technology to control dioxin is not satisfactory.

The typical mass burn incinerator could be a serious pollutant source, unless plant operation and air emissions are rigorously monitored.

Landfills

Although landfills are the most commonly used means of solid waste disposal in Ohio, they are probably the least popular with the public. Odors, dirt, noise, heavy truck traffic and possible groundwater contamination are some of the arguments used to discourage landfill siting. Because liquid residues or leachates have migrated from some older sites into the underlying groundwater, there is serious concern by citizens and environmentalists about this problem and how to solve it.

However, no matter how many alternatives there are in recycling and incineration, some landfills still will be needed for the future. To protect the environment new landfills should be located where the underlying geologic formations and soils will act as a barrier to off-site leachate and methane gas migration. Rigorous geologic site reviews and the use of impervious liners and leachate collection systems in state-of-the-art landfills significantly reduce the risk of groundwater contamination.

Most of these modern landfills are operated by large waste management companies. The small mom-and-pop landfill cannot afford the sophisticated equipment needed to build or maintain these sites as required by the Ohio EPA.

New compacting methods are also used to help conserve landfill space and reduce odors, but compacting may produce problems.

Trash is compacted at a sanitary landfill site by first spreading a uniform layer of waste, then covering it with a certain approved depth of soil, and running over the mass with huge machines that press the soil and trash together. This process creates a layer of organic material that contains very little oxygen. As the waste material is decomposed by bacteria, without the presence of oxygen, methane gas and carbon dioxide are produced.

Methane gas carries odors and is flammable. Because it can migrate underground, it has occasionally caused explosions, even beyond the boundaries of the landfill itself. Modern landfills include methane monitoring, venting, and collection systems, to prevent gas-related dangers.

However, there is an up-side to the methane gas problem. When collected and cleaned, its energy can be tapped just the same as natural gas. Methane recovery systems that pipe methane into gas utility pipelines are now being installed at several sites in Ohio.

An additional obstacle to siting comes from misinformation or misunderstanding on the part of the public. Some people are not aware of the difference between hazardous waste disposal sites and those for solid waste. They may challenge a new or expanded solid waste site, believing it will poison the environment with dangerous chemicals. An open dialogue between waste industry representatives and the public is an important part of the educational process.

THE POLITICS OF SOLID WASTE MANAGEMENT

The technical alternatives to solid waste disposal are admittedly complex and confusing. The political arena where such decisions must be made is just as unwieldy.

Obviously, because community safety and aesthetics are involved, the public and its elected and appointed representatives must play an active role in decision making. But it has been called "political suicide" for an elected official to support siting of a waste disposal facility, particularly a landfill, in his or her jurisdiction.

Though the Ohio EPA sets guidelines for solid waste disposal site operation, the actual enforcement of the regulations is performed by the health departments of each county. Ohio EPA oversees the local health department programs. If the local programs fail to meet approved standards, the EPA takes charge of disposal enforcement in that particular jurisdiction.

Ohio counties with low population density are not able to afford the cost of individual county-owned disposal sites. They may not even be able to afford the cost of evaluating current waste disposal methods, or making long-term projections. These less-dense counties also do not produce enough refuse to make individual sites economically viable.

The current direction of many counties is to form regional waste management ventures, combining multiple counties, towns and municipalities. The joint organization would then submit representatives to map out a long-term waste disposal plan for the region.

The State's Role

In contrast to other states, Ohio has not passed significant solid waste legislation since the Ohio EPA standards were developed in 1976.

Some bills have been introduced, notably a comprehensive solid waste bill and a separate container deposit bill, both sponsored by Representative David Hartley of Clark County. However, both bills have gone through rigorous restructuring. Their fate is far from certain.

Because the problem of solid waste disposal must be addressed, it seems sure that eventually Ohio will pass some form of legislation. What might be included in such a law?

Experts agree that one vital step would be to institute a statewide requirement for solid waste planning, to be carried out by local government entities or regional waste management districts. Though there is agreement that some type of plan is needed, there is much controversy on how the plans would be paid for, and who, exactly, would make the plans for each area.

Legislation might introduce incentives to communities for recycling materials or building waste energy recovery systems.

Another possible subject for a comprehensive solid waste law might be the structuring of a siting task force, similar to Wisconsin's which helps new sites become reality in that state. In Wisconsin, the state Department of Natural Resources reviews the need for waste disposal sites. The decision for need is not subject to negotiation.

After need has been established, Wisconsin's Waste Facility Siting Board, composed of members from both private and public sectors, mandates a series of negotiations between parties to determine the terms of the waste disposal agreement. Both the site applicant and the community interests must negotiate in good faith or be subject to large penalties.

Stalemated negotiators can request Board mediation or arbitration. Since the siting board was launched in 1982, nine negotiated settlements have been achieved, and many others are pending. The applicants tend to think the process is too slow, but the citizens feel they have a voice in the siting process, so are happier with the eventual outcome.

How You Can Help

Solid waste disposal is a problem that must be dealt with. Environmental, social, and financial costs will only escalate if the decision process is delayed.

Interested citizens can get involved by becoming part of the educational effort. They may also participate in waste reduction efforts at work, home, school and church. They may help establish a recycling center and promote its use.

Business and industry representatives need to evaluate the parts they play in producing and disposing of solid wastes. They may consider ways to reduce solid waste volume at the source by changing packaging or processing methods. Incentives for recycling and composting could be established by industry group-efforts.

As regional planning procedures are set up, the public sector, including elected officials, must become active participants. By educating their constituents about the need to provide for local waste disposal, needed facilities can be sited.

The well-being of every community depends on cooperation and sincere negotiation among all interested parties: environmentalists, disposal-site operators, waste generating businesses and manufacturers, political representatives, educators, professional waste-disposal experts, and private citizens.

Ohio should not wait for the solid waste crisis to worsen. Public forums should be sponsored to allow everyone the opportunity to contribute to the solution of this statewide problem. If Ohio citizens give the solid waste issue the attention it deserves today, it will be better able to control the cost and safe disposal of waste in the future.

A current listing of persons and organizations who can provide information on solid waste management is available, upon request, from the OAE office.

BACKGROUND ON LITTER PREVENTION & RECYCLING

The following information was provided by
The Ohio Office of Litter Prevention & Recycling

Litter is misplaced, human generated solid waste. Under Ohio Law Litter means garbage, trash, waste, rubbish, ashes, cans, bottles, wire, cartons, boxes, automobile parts, furniture, glass, or anything else of unsightly or unsanitary nature thrown, dropped, discarded, placed or deposited by a person on public property or private property not owned by him, or in or on waters of the state.

The Office of Litter Prevention & Recycling (OLPR) was created within the Ohio Department of Natural Resources under provisions of the Ohio Litter Control Law enacted in 1980. OLPR's responsibility is to establish and implement Ohio's comprehensive litter prevention and recycling program. The program fights litter through education, law enforcement, collection and containment, and promotes and supports recycling. It is funded by additions to the Ohio Franchise Tax. The Office's intent is to change attitudes and behaviors to achieve a lasting litter prevention ethic, and to foster and promote the maximum feasible amount of recycling.

Why Litter Prevention?

Economically speaking, litter prevention yields cost avoidance. Once solid waste becomes litter, there are two choices: It can be left as litter or it can be removed. Either way, there are economically measurable costs. Leaving it results in injury to us, our possessions and our environment. Feet are cut, automobile tires and farm equipment are ruined, livestock and wildlife are destroyed.

In terms of economic development, leaving litter imposes opportunity costs. A littered community is unappealing to relocating businesses. Littered recreation areas do not appeal to tourists.

Litter removal is costly because it is labor intensive. Per unit of waste, it is relatively more expensive than proper solid waste management. The state of Virginia once estimated that litter was 3% of its solid waste but consumed 16% of public funds spent for solid waste management.

From the standpoint of safety, health and aesthetics there are excellent reasons to prevent litter. Personal suffering, discomfort and aggravation caused by litter are difficult to measure but are nevertheless real and are equally important "costs" to be avoided.

Highway litter causes automobile accidents and injury to highway maintenance workers. Litter on playgrounds and recreation areas, beaches and waterways causes physical injury to those who play out-of-doors and spoils recreational enjoyment.

Littered cans, bottles and rubber tires provide a breeding place for disease carrying mosquitos. Littered household refuse attracts flies, rats, and other disease-bearing vermin.

Litter is ugly and offensive and degrades the quality of our lives by degrading the environment in which we live. It deprives us of the beauty we might otherwise enjoy. It injures animal and plant life we might otherwise appreciate.

Sources of Litter

An early litter researcher identified seven major sources of urban litter:

1. Improper commercial refuse putouts coupled with spillage during collection.
2. Improper household refuse putouts coupled with spillage during collection.
3. Uncovered or inadequately covered trucks and other vehicles transporting loose materials.
4. Construction projects.
5. Loading/unloading operations.
6. Pedestrians discarding litter.
7. Motorists discarding litter.

It has been estimated that 80% of all litter comes from the first five sources named above. Responsible solid waste management practices by home and business owners, waste haulers, landfill operators, industry and builders are necessary for litter prevention.

Motorists and pedestrians deposit litter in urban public areas and on rural roadsides where it often ends on farm land. Less in quantity than litter from the other sources, such litter more often comes to the attention of more people. It is irritating to most of us and contributes an unnecessary hassle to daily life.

A 1968 Gallup poll conducted for Keep America Beautiful, Inc. reported that young people litter two to three times as much as older people, that men litter twice as much as women, that large rural families litter more than small urban ones, and that a majority of people would admit to littering something in the preceding month. Few people will admit to having littered recently.

Some Generalizations About Litter and Littering

Some litter moves by wind, water, animals and human traffic. Wind moves litter across smooth surfaces such as roadways and fields. Rain and running water carry litter from one location to another, until it is trapped. Exposed refuse provides convenient opportunities for dogs, cats and other animals to be carriers of litter. The movement of feet and cars transports litter.

Other litter stays where it is deposited and can be described as part of "permanent" litter cover. Some litter (glass and aluminum) is permanent in another sense in that it deteriorates or biodegrades very slowly or not at all.

Litter can be found anywhere human beings have been. It can be found in Antarctica and on the moon. Urban litter eventually becomes trapped at such locations as:

- vacant lots
- grassy areas
- fences and wall bases
- embankments
- strips between roadways and sidewalks
- catch basins

People are less likely to litter a beautiful environment they feel responsible for maintaining. They are more likely to litter an area that they know to be regularly cleaned. They are more likely to deposit as litter something which has no functional value (e.g. a cigarette butt) than something which is reusable.

Litter varies seasonally. In summer when many people are out of doors, there is more litter and more of it is beverage containers than in winter when there is less litter but more of it is paper.

Investigators have not agreed upon a "basic unit of litter". Litter can be weighed and counted, and its volume can be determined. Litter's effect on the appearance of an area can be objectively judged. Because so many kinds of waste are littered, weights do not translate to volumes nor volumes to counts. There are advantages and disadvantages to each method of measurement. An investigator's purpose in studying litter should be kept clearly in mind when deciding what unit of measure to use in quantifying litter. The choice of method depends on the investigator's purpose. Litter's weight, for instance, is relevant for determining the cost of transportation to a landfill but not for determining its contribution of ugliness to a landscape.

What Can Be Done About Litter?

Litter, again, is misplaced solid waste. It is the responsibility of persons who have control over solid waste at the points it is liable to become litter to contain it properly. When this responsibility is not fulfilled, solid waste becomes litter.

The concept of containment applies to devices ranging from car litter bags to public area litter cans, to the now common "dumpster", to sanitary landfills. Containment is the most appropriate final disposition for some but by no means all solid waste. Most aluminum and glass and much paper can and should be recycled. Given an acceptable technology, unrecyclable solid waste might be incinerated. But all solid waste can finally be responsibly managed only if it is initially contained. If not contained it becomes litter.

There are many approaches to treating the litter problem. None acts against all litter, although some are effective against specific forms of litter. Relative to the point in time when solid waste becomes litter, two kinds of problem treatment approach can be distinguished, the remedial and the preventive. These are discussed below.

Remedial Approaches

Remedial approaches address litter after the fact. They treat litter independently of litter-creating behaviors.

The paradigm remedial approach is the cleanup campaign in which people pick up litter and place it in a container. It is then transported to a final disposition site. Collected litter may be placed in a sanitary landfill or incinerated. Some litter can be recycled.

Many cleanup campaigns are organized as a public service by community civic groups who provide volunteer labor and resources such as publicity and transportation for the litter collected. Organizing and conducting a cleanup campaign can be exciting and satisfying, but volunteer cleanups happen only sporadically.

There are scavengers who collect and sell littered recyclables for profit. No known study provides data on persons who scavenge, on what they collect or on the amount they collect.

For regular cleanup of public places, government action is usually required. Some government agencies clean areas in the course of their main duties. The Ohio Department of Transportation cleans roadsides for the safety of the public and workers, and for the protection of equipment. Parks and recreation agencies clean the areas they maintain for the public.

Through its community grants program OLPR supports volunteer cleanups. It has also developed novel approaches to local cleanup programs using general relief and welfare recipients, and minor misdemeanants sentenced to community service. Since 1981 OLPR has coordinated the Summer Youth Litter Corps to collect roadside litter in the summer.

Another possible remedial approach to some litter is self-destructive packaging. Efforts have been made to develop water soluble glass and photodegradable plastics. Such materials would have to function effectively as inexpensive packaging and then transform into innocuous material upon prolonged exposure to the elements. No materials having all the desired characteristics have yet been developed.

Preventive Approaches

Remedial approaches eliminate existing litter. This is part of the solution to the litter problem. But the problem's scope includes future possible litter as well. Trends in consumer product packaging and in solid waste management costs suggest there will be much future litter. If so, it would be wise to act now to prevent as much as possible. Preventing litter requires changing people's behaviors and attitudes, and there are many ways to do so.

Two preventive approaches can be described as deterrent. Under them, persons who knowingly litter may pay a personal penalty. A penalty is a form of negative reinforcement to extinguish the undesired behavior.

Ohio, like all states, has laws against littering. Littering is a crime for which one can be fined up to $500. A survey conducted by OLPR showed that 80% of Ohioans thought this to be the best way to prevent people from littering. Whether or not a litterer pays the penalty depends on several contingencies: He must be apprehended, convicted and required by a court to pay the penalty for littering. The penalty and the serious intent to enforce the law have been publicized. Whether the public is aware of the threat and what effect it has had upon behavior remain to be studied. It is practically impossible to make imposition of the penalty a dead certainty, but the size of the fine puts may litterers at considerable risk and there may be a genuine deterrent effect. Some individual acts of littering are harmful enough that litter law enforcement serves justice, independently of its deterrent effect.

Beverage container deposit legislation is a second deterrent approach. Enacted in some states, it has been considered and rejected in Ohio. Under such legislation consumers must pay an additional small amount (usually $.10 per container) over what they would otherwise be charged for a container and its contents. The amount paid is returned to the consumer when he or she returns the container to a redemption center. The consumer who litters a container, then knowingly self-imposes a small penalty with absolute certainty. Although the penalty is small, most people will not impose it on themselves. Since not all litter is beverage containers, a container deposit approach will not deter all litter. Controversy surrounds the beverage container deposit approach. There is factual disagreement and disagreement about whether it is fair to those on whom it imposes cost. What portion of litter is beverage containers? What are the costs of implementing container deposit laws, and on whom could they fairly be laid? There is not consensus as to the corroct answers.

There are also more positive approaches. Public awareness campaigns use marketing techniques such as publicity, media advertising and public relations. They induce voluntary containment of waste and make the public aware of the reasons for proper containment. Such campaigns can be as simple as placing messages ("prompts") near "user friendly" containers politely asking passerbys to use the container. Awareness campaigns often inform or remind the public of the economic, safety, health, environmental and aesthetic cost litter imposes.

Ohio is one of several states which emphasize the importance of education as a positive approach to litter prevention. In schools, children acquire skills and habits which will serve them throughout their lives. Commonly used approaches are school ground cleanups and poster contests. Curriculm materials available to teachers suggest how litter prevention themes can be incorporated into classroom teaching. By including an understanding of the need for proper waste management in the educationally managed development process, teachers contribute to the quality of life in Ohio's future.

RECYCLING

Recycling is the recovery and reuse of materials which would otherwise be wasted. It involves collecting waste materials and reprocessing them to serve

as raw materials in the manufacture of new products. Waste materials can be recycled only if there is an appropriate technology for reprocessing them. Waste' recyclability also depends on their initial design as consumer goods. Recycling is a well-established practice in many communities. The recycling emphasis of OLPR is on residential solid waste. The most commonly recycled household materials are aluminum and tinned steel cans, glass, paper, oil and certain plastics, for all of which there are appropriate recycling technologies.

The value of recycling, like that of litter prevention, derives primarily from costs avoided, but there are positive benefits. Recycling results in conservation of energy and natural resources. Making products from recycled materials requires far less energy than making them from unprocessed virgin materials. Recycling results in reduction of the volume of solid waste and consequently in avoidance of waste disposal costs and in conservation of existing landfill space. This is especially true of paper recycling. Recycling is sometimes credited with litter reduction. Positively, at the local level, recycling activities produce revenue and can be a source of employment or training opportunities.

Recycling operations come in several forms, discussed below. All successful recycling operations require community support, an available supply of recyclable materials, and the location of markets in the area for the materials.

Several forms of community support may be needed, but the core support is residents' willingness to recycle some household wastes. Because of this, a recycling operation must include recycling promotion through public awareness campaigns.

The availability of materials to a recycling operation is largely a function of the size of the community in which the program operates. The more households, the more available recyclables. Smaller communities can make recycling programs work through intensified public commitments to recycle. Also, household recyclables can be supplemented by glass and aluminum from restaurants and bars, and by waste paper from department stores and business offices.

If there is no market for collected recyclables, there is no point in collecting them. There must be a market with prices high enough to enable a recycling operation to meet its business goals. In determining how high market prices would have to be, a recycling operation must consider other costs than those of simply collecting the recyclables. Some markets demand that materials be treated in special ways: glass must be separated according to color, or paper bundled in a certain way. If this preparation costs more, will the available price compensate for it? The greater the distance to market, the greater the transportation costs which must be taken into account also.

Donation/Drop-off Recycling Programs. The most common form of residential waste recycling operation is the drop-off center. Drop-off centers accept recyclables from individuals and businesses who bring already separated materials into the center's location. Unstaffed newspaper-only operations are more common than multi-material operations.

There are many methods of operations. Drop-off centers may be fully staffed with regular business hours or be completely unstaffed with 24-hour

accessibility. Some centers do little or no processing of materials and simply store materials in 55 gallon steel drums or in containers provided by the buyer of the materials. Large volume operations usually own or lease processing equipment and bale or crush material to save space and improve marketability. Drop-off centers can be sponsored by governments, private businesses, civic, or environmental groups, or a combination thereof. Privately operated centers are often associated with waste collection or secondary material firms, and some costs of management and operation of the recycling center are partially subsidized by the primary business. Programs operated by local governments or non-profit groups usually have access to "free" or partially funded labor pools such as general relief workers, alternative sentencing program referrals, persons employed through federally subsidized jobs programs, and volunteers. The two key elements affecting public participation are convenience of location and effective use of promotion and advertising.

Drop-off centers are relatively easy to set up and can require little capital investment. They are typically low budget programs to operate. They can be partially supported financially by other businesses, local governments and non-profit groups. They often lack a good management plan. Most have low profit margins and consequently may be forced out of business in a depressed recycling commodities markets period. Local zoning ordinances often prevent securing a location convenient to patrons. Unstaffed depots are often the target of vandals and litterers, and often receive unwanted, unmarketable items.

Buy-back Recycling Programs. Buy-back recycling programs pay for the recyclable materials people bring to the center. They are an outgrowth of the long-established commercial recycling industry and commercial waste generators. Unlike their predecessors they focus on recovering post-consumer wastes from the residential sector. Most are single material programs collecting aluminum cans, but the number of multi-material operations is increasing.

In Ohio both the state government and the private sector are major supporters of multi-material buy-back recycling centers. OLPR awards grants for the establishment or expansion of recycling centers owned and operated by non-profit corporations. The Ohio Business and Industry Recycling Program promotes and supports a network of Recycling Stations, multi-material centers that meet minimum cleanliness and material handling standards.

The major operational differences between drop-off centers and buy-back centers relate to procedures and equipment used in the purchasing transaction (i.e. scales and cash registers). Payment is made based on weight, and staff must be present to weigh and pay accurately. Buy-back centers require that customers satisfactorily prepare recyclable materials before receiving payment. Buy-back center personnel therefore spend less time upgrading materials prior to shipping them to market than drop off center personnel. Buy-back centers perform well in low-income areas where residents undertake recycling as an alternative source of income.

Buy-back centers can be important providers of jobs and income in economically depressed areas. The cash incentive draws participants from a larger geographical area then a drop-off program. They face the same problems drop-off centers do regarding market stability and zoning problems. They also face cash flow problems. Adequate start up capital and ongoing cash reserves are crucial for an operation which must steadily pay out money while accumulating enough material to market cost effectively. Buy-back recyclers

often wait two to four weeks for payment from a buyer once materials are delivered to market.

Curbside Recycling. Curbside programs capture recyclable materials very close to the point of generation. Household residents separate specified recyclable from household wastes and place the recyclables at the curb on days designated for collection. The recycables are then picked up by the local government's sanitation crews, a private waste hauler, or a recycling program operator under contract to the local government.

There are many options in organizing a curbside recycling program. Decisions concerning mandatory vs. voluntary participation, which materials to recycle, how frequently to pickup materials, and how much preparation of materials by residents is desirable or practical, can be specifically tailored to an individual community's needs.

Single-item curbside programs usually collect newspaper. It is an easily separated material and by weight can represent a significant portion of a household's solid waste. Multi-item curbside programs most often include glass bottles and jars and aluminum cans in addition to paper. Residents are usually asked to separate all three items at the curb, to clean bottles and jars and to bag or tie newspaper. Some programs provide special containers to residents for storing recyclables at home.

Participation levels are often highest in small communities where disposal problems have high public visibility and a high percentage of the population is in the upper income bracket. Communities that establish mandatory recycling ordinances also usually have a higher level of citizen participation.

Most curbside programs collect materials weekly. Weekly collection attracts more participants and diverts more waste from the solid waste stream. Biweekly collection costs less. Newspaper-only curbside programs typically handle collection of newspaper by fitting existing collection vehicles with simple racks or bins. Multi-material curbside programs often use built-to-order collection vehicles with bins for separate materials or use specially compartmentalized trailers towed behind a pickup truck.

Curbside programs focus on 5 to 25 percent of the residential waste stream, depending on the number of materials collected and the composition of the local waste stream. The actual amount diverted depends on the responsiveness of residents to the program.

Curbside recycling is the most convenient system for users and has the greatest waste diversion potential. In many municipalities recycling collection and waste collection can be readily combined and carried out as a city-wide service. Like all forms of recycling it is subject to the vagaries of markets and public participation. A problem unique to it is the scavenging of materials set out at curbside, especially aluminim. Anti-scavenging ordinances can be enacted but are difficult to enforce. Waste collection arrangements may also pose a problem if the community is serviced by multiple waste haulers who may object to what they see as a threat to their business, but who are incapable of providing the desired recycling service. Presently in Ohio there are curbside recycling programs operating in Cleveland Heights (newspaper only), Barberton and Athens (both multi-material).

Recycling at the Disposal Site. There are several options for recovering recyclable materials at the transfer station or landfill. Source separated materials may be brought to the disposal site by residents who haul their own waste for drop-off at an area reserved for recycling. This type of activity at disposal sites in rural areas in particular can be readily accessible to many residents. Public participation can be increased by offering financial incentives such as discounted waste disposal charges for recyclers. Mandatory participation ordinances requiring citizens to separate recyclables from trash can also be used to increase public participation. Operational needs for overseeing the drop-off area and processing and shipping recyclables can often be partially or completely met by existing disposal site staff and equipment. In addition to the usual market considerations, care must be taken to assure timely shipment of materials to avoid disruption of work at the disposal site.

Site-separation is a recovery process in which materials are sorted from mixed residential and commercial waste. Old corrugated containers are the most frequently recovered item in this type of recycling program. Commercial waste loads are more frequently targeted for separation than residential wastes because of the greater volumes of old corrugated containers produced by businesses. Typically the wastes are dumped on a tipping floor where portions of the load which have a high recyclable content are pushed to a sorting area. Recyclables are then hand picked from other refuse and fed into a mechanized processing system involving equipment such a conveyors, trammels and balers.

Disposal site recycling programs mesh well with existing recovery and disposal operations. Post-disposal recycling systems capture recyclables that have bypassed other recyclers and allow waste haulers to continue their established methods of business. A major disadvantage of site separation recycling can be high labor costs for initially separating materials for upgrading materials before they can be sold. Often material is simply too contaminated by other wastes to be marketable.

Role of the Ohio Office of Litter Prevention & Recycling. OLPR advises local units of government in Ohio in developing and improving laws, programs and policies for recycling. It engages in educational and motivational campaigns to foster and sustain public awareness of the need for recycling. It makes grants to local units of government to support the development and implementation of local, community oriented recycling programs. It identifies existing and potential markets for recycle goods. It encourages agencies of the state to purchase and use products manufactured from recycled materials.

HOW TO FIND INFORMATION ON LITTER PREVENTION AND RECYCLING

Sorting through the maze of publications and information sources on litter prevention and recycling is difficult work. A serious error of first time researchers is trying to do too much. You'll be able to do a better job if you narrow your topic.

For example, if you've chosen litter prevention and recycling as a general area of research, and if you are trying to formulate a question or problem, you need to understand that information can be broken down into smaller units. Soon you'll reach an area that is limited enough to allow you to proceed until you have exhausted the available sources of information.

The broad topic of litter prevention and recycling may be divided into

o knowledge of waste and the environment and

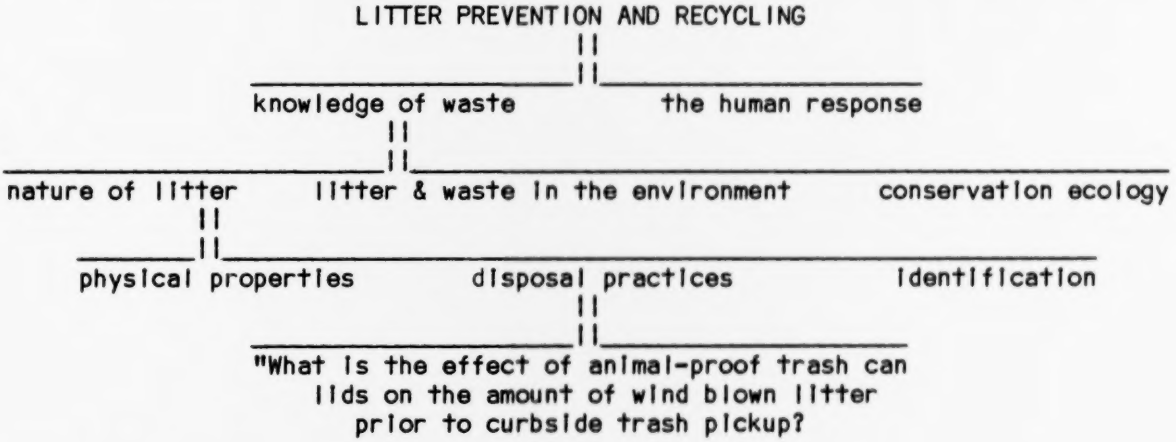
o the human response: knowledge into action.

Knowledge of waste may be limited to nature of litter, litter and waste in the environment, and litter and waste as important considerations in conservation ecology. If you are particularly interested in the nature of litter, you'll soon discover that you can be even more specific. Projects on litter may be concerned with the physical properties of waste, the various disposal practices and ways you can identify waste by ecological categories.

Projects on disposal practices may be concerned with trash containers. You may focus your research on the problem or question of:

"What is the effect of animal-proof trash can lids on the amount of wind blown litter prior to curbside trash pickup?"

The following diagram illustrates the concept of narrowing the topic.


LITTER PREVENTION AND RECYCLING
knowledge of waste
the human response
nature of litter
litter & waste in the environment
conservation ecology
physical properties
disposal practices
identification
"What is the effect of animal-proof trash can lids on the amount of wind blown litter prior to curbside trash pickup?

USING THE LIBRARY

Let's look at how you might use your local library to find more information. Although advanced research requires access to university and

research libraries, you'll find that your local library will give you access to a world of information if you'll only ask.

CARD CATALOGUE

The first stop in the library will probably be the card catalogue. Here you'll find, arranged by author, title, and subject, a complete listing on cards of the books available in the library. Some libraries now have computer terminals with "on-line" catalogues which may be searched rapidly for publications related to your topic. These "on-line" catalogues often are useful to find publications which, although not in the library you are visiting, may be borrowed from other libraries through inter-library loan. The card catalogue will list circulating books, which are usually stored on long rows of shelves or stacks. You can also use the card catalogue to find non-circulating reference books.

REFERENCE BOOKS

Reference books include science encyclopedias which can be used as a starting point in your research to get an overview of the subject. A top quality research project, however, must use many other sources of information since encyclopedias are general and seldom are useful beyond the early stages of your work.

Handbooks of standards, formulas and data will be helpful in determining whether your results are similar to those obtained over the years by other researchers. Handbooks also provide information on mathematical conversions and basic chemical and physical science data such as constants and properties of materials.

Learn what Standard Industrial Codes (SIC) mean and how you can use them to identify companies involved in waste management. You can find companies listed by SIC's in Harris's Ohio Industrial Directory. The SIC system separates all business units into many broad divisions such as Food and Kindred Products, Chemical and Allied Products and Rubber and Miscellaneous Plastic Products. The system further subdivides each division. For example:

Industry breakdown	Code	Industry or Product
Major industry group	30	rubber & misc.
Specific industry	3031	reclaimed rubber

According to the Directory, eight Ohio companies are involved in reclaiming rubber.

TRADE AND TECHNICAL JOURNALS

Much of the information you may need will be found in trade and technical journals published by trade and professional associations. University and

Industrial libraries and libraries of some federal, state and local government offices may subscribe to the following publications:

- Waste Age
- The Management of World Wastes
- Conservation and Recycling
- BioCycle (formerly Compost Science)
- Resource Recycling
- Phoenix Quarterly
- Journal of Environmental Management
- Journal of Social Psychology
- Journal of Resource Management and Technology

INDICES

Newspaper, magazine and journal indices give you access to a broad range of publications. Nearly every library will have the Readers Guide to Periodical Literature which allows you to find articles in popular publications. Often, the library will have a copy of the publication or the library may have a microfilm or microfiche copy for viewing and copying in a special reader. One of the most exhaustive indices is Current Contents, a weekly publication which reproduces the "contents pages" of thousands of journals and provides subject and authors indices. The monthy Applied Science and Technology Index is also helpful.

ABSTRACTS

Abstracts publications provide extensive listings of research reports and technical papers presented at meetings or published in scientific and engineering journals. Although not always available in many local libraries, most college libraries have abstract publications on energy, the environment, chemistry, physics, mathematics, and social sciences. An abstract publication called Pollution Abstracts, which has an annual index, contains dozens of references on recycling and other aspects of solid waste. Each April The Ohio Journal of Science publishes nearly 350 abstracts of papers presented at the Annual Meeting of The Ohio Academy of Science.

VERTICAL FILE

The vertical file, sometimes called pamphlet file, often contains useful information not found by other means. Here you'll find publications from state and Federal agencies, corporations, trade and professional groups. The materials usually are arranged by subject and filed in large folders.

DEVELOPING AND TESTING HYPOTHESES

A successful science day project must have a testable hypothesis. An hypothesis is a statement describing an expected outcome of an experiment. It is what the researcher expects to happen. The following table outlines three problems or questions and suggests three corresponding hypotheses which may be tested.

Problem	Hypothesis
What is the effect of animal-proof trash can lids on the amount of wind blown litter prior to trash pickup?	Animal-proof trash can lids will reduce the amount of litter produced prior to trash pickup when compared with cans without animal-proof lids.
Where is restaurant litter most likely to be found?	Litter is concentrated within the first one quarter mile from fast food restaurants.
What is the most important factor influencing behavior of persons to recycle beverage cans?	The market price of cans is the greatest factor motivating beverage can recyclers.

All of the project ideas in this book lend themselves to the development of testable hypotheses.

ADDITIONAL REFERENCES AND SOURCES OF INFORMATION

SOME GROUND RULES

In this section we have listed references and sources of information to enable students to go as far as they would like to in seeking detailed and specific information on litter prevention and recycling.

Before encouraging students to contact these sources it is imperative that teachers give students some ground rules:

1. Be sure that students have written proposals or research plans for their projects including specific problems or objectives. They should also be expected to write an hypothesis, spell out the several steps in their methods and list the materials or equipment needed.

2. Students should exhaust local library resources first. Too often students write or call corporations, governmental agencies and institutions without first "doing their homework."

3. Instruct students to write letters which request specific information and not everything under the sun. Two examples follow:

Unacceptable Letter

Mr. J.D. Smith
Director of Public Information
XYZ Corporation
Anytown, OH 43215

Dear Mr. Smith:

I am doing a science project on litter. I don't know anything about this subject except that there is a lot of it, so will you please send me everything you have on the subject.

I need to finish my project by Friday, so would you please hurry?

Sincerely,
Bill Smith

Bill Smith

P.S. My friend Sally is doing her project on guppies. She asked me to ask you for information on guppies too.

This is an unacceptable letter for the following reasons:

1. No date.
2. No inside address for return of information.
3. Request is too general; asks for everything under the sun.
4. Student has not narrowed the topic.
5. Student has not exhausted local library sources first.
6. Response time (by Friday!) is too short.
7. The student should not ask questions for someone else, especially when they are unrelated (guppies?).

Acceptable Letter

William Smith
123 Smith Street
Smithton, OH 12345
(419) 333-4444

December 1, 1986

Mr. J. D. Smith
Director of Public Information
XYZ Corporation
Anytown, OH 43215

Dear Mr. Smith:

I am doing a student research project on the effects of animal-proof trash can lids on the amount of litter generated prior to curbside trash pickup. I have exhausted the resources at my school library, the local public library, and the nearby college library. I have also corresponded with Dr. G. F. Ritter at the University of Denver.

Knowing that the XYZ Corporation has produced trash cans for many years I thought that you may be able to help me locate recent data on the how animal-proof lids can reduce litter prior to curbside trash pick up.

Do you have any recent reports or data which you could share with me? Is there someone at XYZ Corporation who would be willing to talk with me about this request?

To help you respond to my questions I have enclosed my research plan and a summary of the information I have collected.

Thank you for your consideration of my request.

Sincerely,

William Smith

William Smith

Enclosures

This letter is more acceptable for the following reasons:

1. Includes return address, phone number and date.
2. Student shows evidence of using local library resources.
3. Request is more specific than other letter.
4. Student is sending a description of the project and a summary of his background information which will help the person at the XYZ Corporation respond without duplicating information already collected.
5. Shows that student is already familiar with corporation
6. Student suggests that talking with someone may be helpful. Although this is not always possible, it is a good way be begin a mentor relationship.

7. Student is polite ("Thank you for your . . .) and is not demanding that a response be sent by Friday!
8. Student doesn't ask help for his friend.

CURRICULUM GUIDE

Guidelines for development of courses of study in energy and resource conservation are available from The Ohio Department of Education, Division of Elementary and Secondary Education, 65 South Front Street, Columbus, OH 43215. Phone (614) 466-2211.

REFERENCES AND RESOURCES

The following references and sources of information on litter prevention and recycling are representative but not exhaustive. They will provide a starting point to help students begin their research.

SOURCES OF INFORMATION - ORGANIZATIONS AND AGENCIES

OFFICE OF LITTER PREVENTION & RECYCLING
DISTRICT OFFICE ADDRESSES

DISTRICT I
Nexida Felicano, Coordinator
OLPR District I
Building E-1, Fountain Square
Columbus, OH 43224
(614) 265-6375

DISTRICT II
Karen Taylor, Coordinator
OLPR District II
952 Lima Avenue, Box F
Findlay, OH 45840
(419) 423-1850

DISTRICT III
Mark Ditz, Coordinator
OLPR District III
2756 S. Arlington Road
Akron, OH 44312
(216) 644-7838

DISTRICT IV
Larry Cooper, Coordinator
OLPR District IV
1703 Smith Bridge Road, P.O. Box 691
Jackson, OH 45640
(614) 286-7427

DISTRICT V
John Wolary, Coordinator
OLPR District V
8570 East St. Rt. 73
Waynesville, OH 45068
(513) 897-0812

OTHER ORGANIZATIONS

Mr. Sam McCracken
Director of Public Relations
Aluminum Association Inc.
818 Connecticut Ave. N.W.
Washington DC 20006
(202) 862-5100

Mr. Robert B. Peabody
President
American Iron and Steel Institute
1000 16th St. N.W.
Washington DC 20036
(202) 452-7100

Dr. William H. McBeath
Executive Director
American Public Health Assoc.
1015 15th St. N.W.
Washington DC 20005
(202) 789-5600

Mr. Russell F. McKinnon
Executive Vice President
Automobile Dismantlers & Recyclers Assoc.
1133 15th Street N.W.
Washington DC 20005
(202) 429-9440

Mr. Larry L. Long
Executive Director
County Commissioners' Assoc. of Ohio
40 South Third St. Suite 510
Columbus OH 43215
(614) 221-5627

Mr. H. Lanier Hickman Jr.
Govt. Refuse Collection & Disposal Assoc.
P.O. Box 7219
Silver Spring MD 20910
(301) 585-2898

Dr. Herschel Cutler
Executive Director
Institute of Scrap Iron and Steel
1627 K St. N.W. Suite 700
Washington DC 20006
(202) 466-4050

Mr. Richard M. Cooperman
Executive Director
Aluminum Recycling Association Inc.
Suite 504 900 17th St. N.W.
Washington DC 20036
(202) 785-0951

Mr. Louis F. Laun
President
American Paper Institute Inc.
260 Madison Ave.
New York NY 10016
(212) 340-0600

Mr. Michael Krissoff
Executive Director
Asphalt Recycl. & Reclaiming Assoc.
1133 15th St. N.W.
Washington DC 20005
(202) 429-9440

Mr. John M. Dunn
President
Can Manufacturers Institute
1625 Massachusetts Ave. N.W.
Washington DC 20036
(202) 232-4677

Mr. William W. Sadd
President
Glass Packaging Institute
6845 Elm St. Suite 209
McLean VA 22101
(703) 790-0800

Mr. Neil Seldman
Director
Institute for Local Self-Reliance
2425 18th St. N.W.
Washington DC 20009
(202) 232-4108

Ms. Dorothy S. Ridings
President
League of Women Voters of the U. S.
1730 M St. N.W.
Washington DC 20036
(202) 429-1985

Mr. M. J. Mighdoll
National Assoc. of Recycling Industries
330 Madison Ave.
New York NY 10017
(212) 867-7330

Mr. David Gatton
Executive Secretary
National Resource Recovery Assoc.
1620 Eye St. N.W.
Washington DC 20006
(202) 293-7330

Mr. Eugene J. Wingerter
Executive Director
National Solid Waste Mgmt. Assoc.
1730 Rhode Island Ave. N.W.
Washington DC 20036
(202) 659-4613

Mr. Robert Lambert
Ohio Auto & Truck Recyclers Assoc.
15820 Normandy Ave.
Cleveland OH 44111

Mr. Michael Shoemaker
Ohio Council of Retail Merchants
50 W. Broad St. Room 1616
Columbus OH 43215
(614) 221-7833

Ms. Nancy L. Moore
Manager - Solid Waste
Ohio Environmental Protection Agency
361 East Broad Street
Columbus OH 43215
(614) 462-8386

Mr. Carl Broberg
Research Director
Ohio Municipal League
40 S. Third Street Suite 540
Columbus OH 43215
(614) 221-4349

Plastic Bottle Institute
355 Lexington Ave.
New York NY 10017

Mr. Gary Liss
President
National Recycling Coalition
45 Rockfeller Plaza
New York NY 10111
(212) 765-1800

Mr. Frederick L. Webber
President
National Soft Drink Assoc.
1101 16th St. N.W.
Washington DC 20036
(202) 463-6732

Mr. George Peters, Jr.
Office of Litter Prevention & Recyc.
Fountain Square
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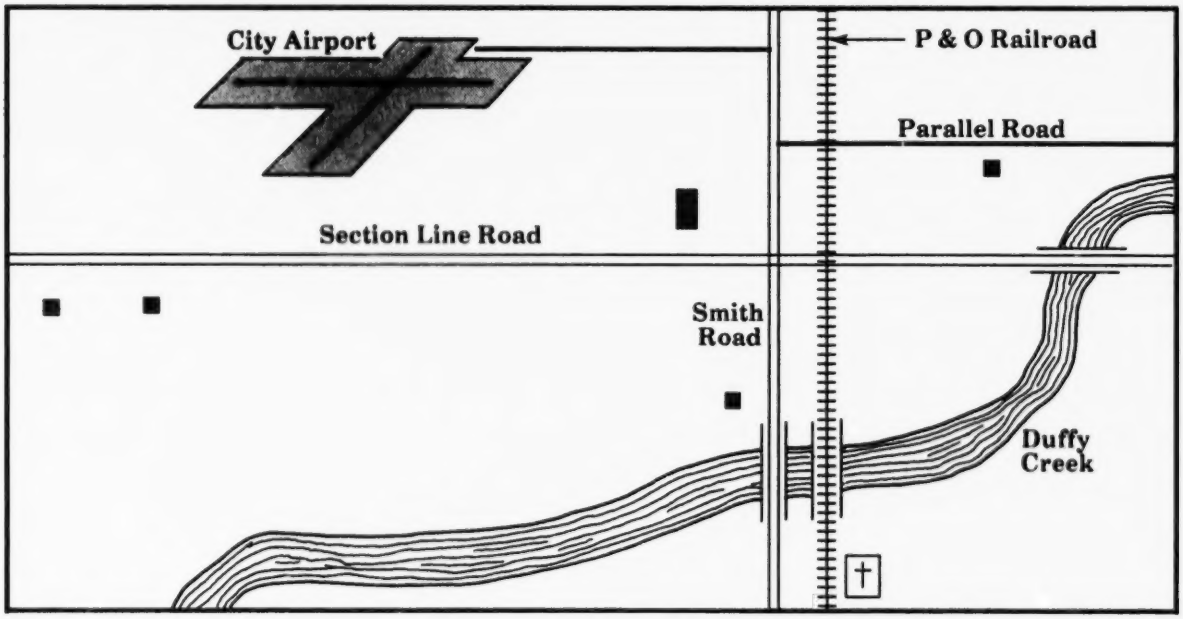
SUGGESTED STUDENT RESEARCH PROJECTS

DETERMINING THE BEST LOCATION FOR A NEW SANITARY LANDFILL



BACKGROUND

A very serious problem arises when there is a requirement to establish a new sanitary landfill site. Modern landfill design and operating techniques can result in vermin free, odor free, litter free, nicely landscaped facilities which are significantly more acceptable than the trash dumps of earlier years. Still, it seems that nobody wants a landfill located next to their home or place of business. The "NIMBY" (Not In My Back Yard) syndrome and other environmental concerns have kept many Ohio counties and communities from being able to locate acceptable sites for desperately needed landfills. Assume that your local landfill will soon be full, and there is a need to locate an acceptable site for a new sanitary landfill. Some of the factors you need to consider are (1) the location of existing and planned land developments, (2) the protection of streams and ground water and (3) efficient transportation routes for garbage trucks.

PROBLEM

Determine for your city, township or county, the best two or three potential sites which might be suitable locations for a new landfill.

METHODS AND MATERIALS

Obtain current landfill siting requirements from the Ohio EPA, 361 East Broad Street, Columbus, OH 43215. Examine current and projected land use maps at local governmental planning offices. Use topographic, geologic and soils maps.

Develop a computer graphics model or other means of plotting the relationship of critical factors such as soil, transportation routes, groundwater aquifers, nearness to residential areas, flood plains and other constraints on the acceptability of potential sites. Project or predict the two or three sites best fitting the siting requirements set by law and the factors you determine are critical.

REFERENCES AND RESOURCES

Your primary resources for this project will be various types of maps showing the land use, soils and geology of your county. These maps can be obtained for a reasonable fee from your county engineer, county Soil Conservation Service, Cooperative Extension Service, county planning department or other local government departments. Also obtain copies of state and local landfill siting requirements from the Ohio EPA, 361 East Broad Street, Columbus, OH 43215. For comprehensive information on geology and soils contact The Ohio Department of Natural Resources Publications Office, Fountain Square, Bldg. B-1, Columbus, OH 43224.

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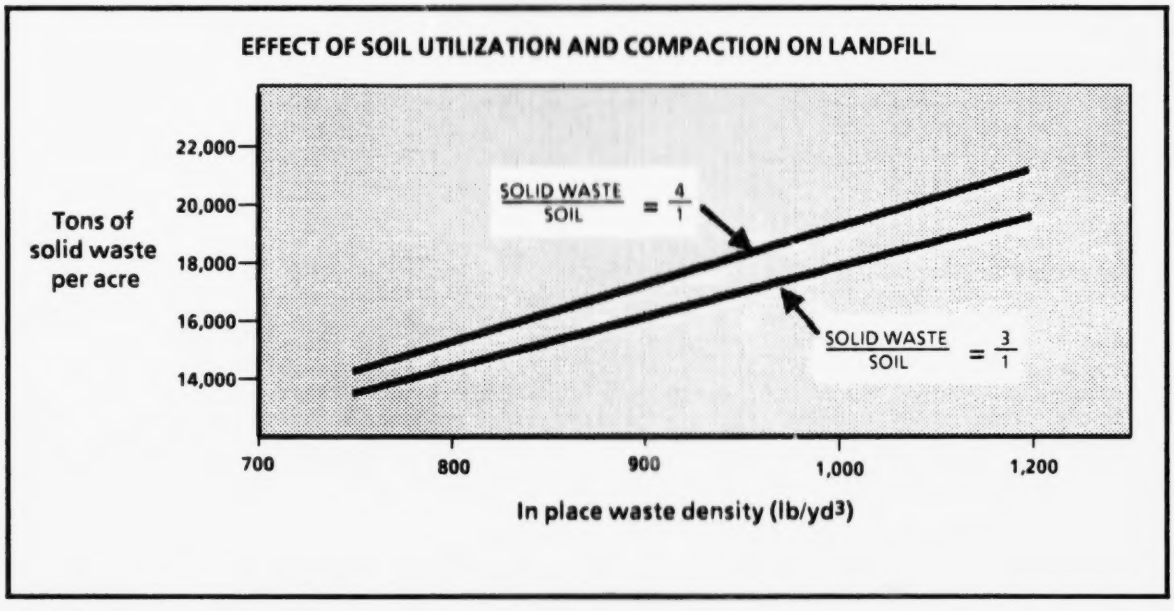
See especially the following reference:

O'Leary, Phil, Berrin Tansel and Rick Fero. 1986. Landfill Lesson Eight: Site Plan Preparation. Waste Age 17(8):88.

CREDIT Mr. Gary E. Smith, Systech Corporation, 245 North Valley Road, Xenia, Ohio 45385

DETERMINING THE APPROPRIATE SIZE FOR A NEW SANITARY LANDFILL



BACKGROUND

In the United States more than three pounds of solid waste are generated by each person each day. At that rate, a community of 10,000 people will generate nearly 11 million pounds of solid waste each year. Some of these solid waste materials like aluminum, glass and newspaper can be recycled and reused. Some components including paper, plastic and wood can be burned to reduce their volume and recover their energy content. Unfortunately, only a very small percent of the solid waste generated is actually recycled or incinerated in waste-to-energy facilities. The remainder must be disposed in a sanitary landfill.

Assume that you have successfully located an appropriate site for a new sanitary landfill. (See "Determining The Best Location for a New Sanitary Landfill".)

PROBLEM

Determine how big a new landfill must be and how long it could be used in your community.

METHODS AND MATERIALS

There are numerous factors to be considered including the following for a potential or actual landfill:

1. What size population will the landfill serve?
2. How long would you expect the landfill to last?
3. How fast is the population expected to grow?
4. Should you consider the needs of neighboring communities?
5. What are the current and projected levels of recycling?
6. Are there plans for or the need for a waste-to-energy facility?
7. How much waste could possibly be recycled or burned?

By using reasonable round number estimates of some of these factors it is possible to come up with very reliable projections of the size requirements for your new landfill. You will need to find a few facts about municipal solid waste (MSW), local recycling activites and local population trends. With this information, make your preliminary projections. Next determine which of your factors is the weakest (more of a wild guess that an educated estimate) or which factor is likely to have the most impact on the final estimate (highest sensitivity). Reevaluation of these weak or sensitive pieces of information will serve to refine your estimate of the required size for the new landfill facility. Continue your research and refine your estimate until you are confident that you have a sound projection on which designers can rely. NOTE: consider the development of mathematical and/or computer models to describe the relationships of the variables.

REFERENCES AND RESOURCES

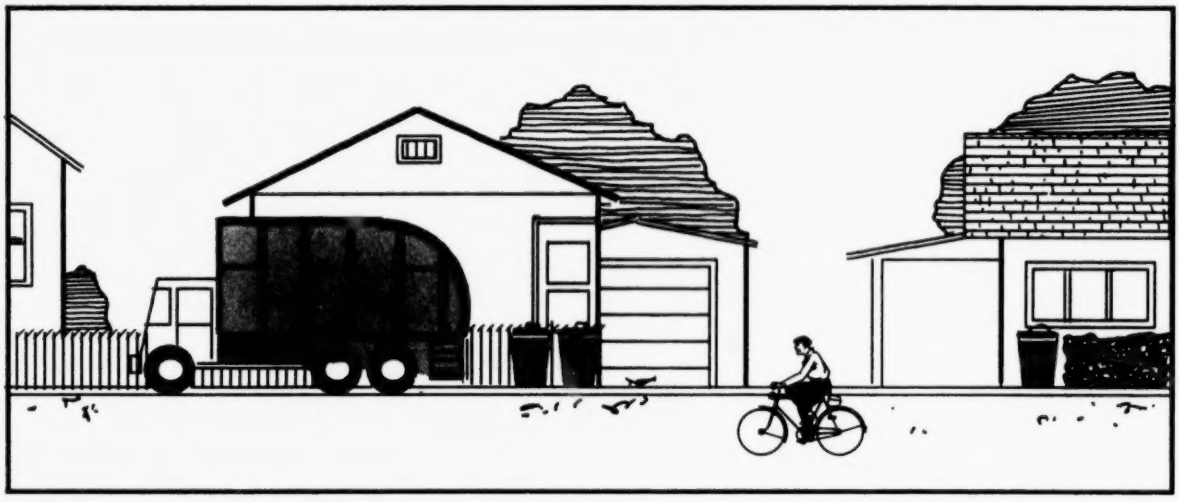
Some of the required backgound information can be found by looking up references in the card catalog on municipal solid waste and sanitary landfills. Many details relate specifically to your community and must be obtained from local officials or publications.

See especially the following reference:

O'Leary, Phil, Berrin Tansel and Rick Fero. 1986. Landfill Lesson Seven: Landfill Design Procedures. Waste Age 17(7):84-95.

CREDIT Mr. Gary E. Smith, Systech Corp., 245 N. Valley Road, Xenia, OH 45435

CONTROL OF LITTER RESULTING FROM TRASH COLLECTION



BACKGROUND

Trash is collected along the curb in most cities. The trash is very often placed in open containers or plastic bags. The plastic bags contain sufficient evidence of food to attract animals which open the bags. As a consequence, trash blows throughout the neighborhood. In addition, when trash is collected, insufficient care, probably due to limited collection time results in additional loose trash. In some cases, trash blows from collection trucks.

PROBLEM

Determine the effectiveness of types of containers with wind or animal resistant lids to prevent litter.

METHODS AND MATERIALS

Research local community laws relative to specifications of trash containers. If adequate laws exist, are they enforced? If trash container laws do not exist or are not adequate, what needs to be done? Examine several types of containers and determine the best wind and animal resistant designs. You may also want to develop a conceptual design of an efficient, easy to use, and low cost method to cover open beds on trucks that carry trash. Are rules and laws adequate to support and promote care when the trash is collected? Make a survey of two different residential areas: one with a private competitive trash

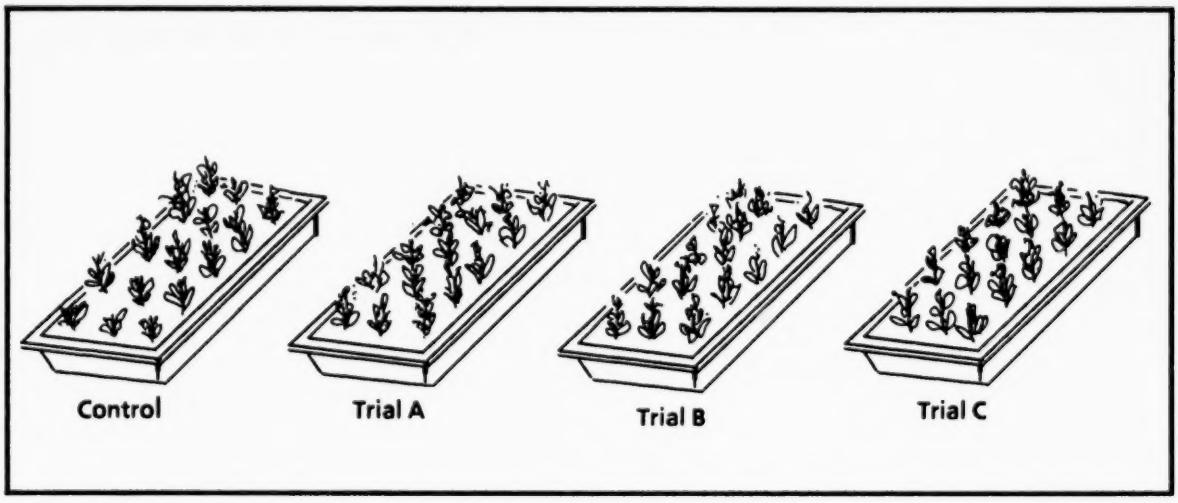
collection company and another with a single tax supported company. Are there differences in the services? Does one type of service promote more care and concern in trash handling? You may want to to use a remote surveillence technique such as still or video cameras to record and analyze actual trash pick up operations. Careful examination of photogaphs or video footage may reveal the origin of trash.

REFERENCES AND RESOURCES

Contact your local refuse collection service for information on trash containers. Find manufacturers of trash containers by examining products at local stores or by using industrial directories in the library.

CREDIT Rockwell International, Columbus, Ohio

EFFECTS OF LITTER ON PLANT LIFE



BACKGROUND

Most people that litter do so because they believe litter will not cause harm. Many people believe that although litter may not look good, it is only industrial waste that harms the environment.

PROBLEM

Determine the effects of various materials from litter on plant life.

METHODS AND MATERIALS

Several types of common litter should be collected including papers with various types of prints, colors and materials. Collect discarded cans made of various materials and used for different applications. The collected materials should be sorted, broken into small pieces and mixed in the soil or water to determine effects on plants. Sufficient litter materials should be used so that the effect on the health of the plant(s) can be observed. Be sure to have a

control group of plants, isolated from the others, which does not receive applications of litter. Use adequate number of plants and repeated trials. As an alternative you could use six different kinds of plants and determine the relative difference of effects of litter (for example, newspaper) on each plant species.

REFERENCES AND RESOURCES

Consult basic texts on soil and plant growth.

CREDIT Rockwell International, Columbus, Ohio

ESTABLISHMENT OF A METHOD TO CLASSIFY LITTER BY ITS POTENTIAL AS A HEALTH AND SAFETY HAZARD

Site	Percent of Hazardous Litter					
	<10	11-25	26-50	51-75	76-90	>90

BACKGROUND

Most people think litter is unsightly but not harmful. There is a need to classify litter by health and safety categories. There is also a need to determine if certain geographical areas are more susceptible to harmful types of litter such as discarded aerosol cans and other household chemical containers, broken glass and metal objects, restaurant litter which may harbor harmful bacteria, or used tires which may serve a breeding sites for disease carying mosquitoes.

PROBLEM

Develop a method to classify litter by its potential as a health and safety hazard.

METHODS AND MATERIALS

Collect litter in various locations such as residential areas, schools, business areas, industrial locations, parks, shopping centers, etc., and

classify the litter according to health and safety hazards. Establish where most harmful litter occurs and what types of litter are present. Establish where most litter is non-biodegradable, an affront to human aesthetic sensitivity and may have a direct effect on health and safety. Also determine areas where wastes are a hazard to plant, animal, or human life. Establish geographical categories like schools, parks, businesses and residential areas and rank them for their potential as having the greatest need for litter control and prevention. The result would be to establish areas and types of litter that require immediate action for health and safety reasons. Be sure to define the limited of your study area. You may want to mark the boundaries on a city or county street or road map.

REFERENCE AND RESOURCES

Consult references on hazardous wastes and other health and safety aspects of litter. Check with the environmental health officer of the county health department or The Ohio Department of Health, 246 North High Street, Columbus, OH 43215.

CREDIT Rockwell International, Columbus, Ohio

WHY DO PEOPLE LITTER?

Subject	Age	Do You Litter?			Where do you Litter?	Why do you Litter?
		Yes	No	Sometimes		

BACKGROUND

Although numerous methods including strict laws have been used to stop the litter problem, many people still continue to discard waste materials indiscriminately. The problem includes individuals as well as organizations. Stricter laws and increased enforcement may reduce litter but many not provide the ultimate solution to the problem. The basic problem is to convince people not to litter or indiscriminately discard waste.

PROBLEM

Determine why people litter.

METHODS AND MATERIALS

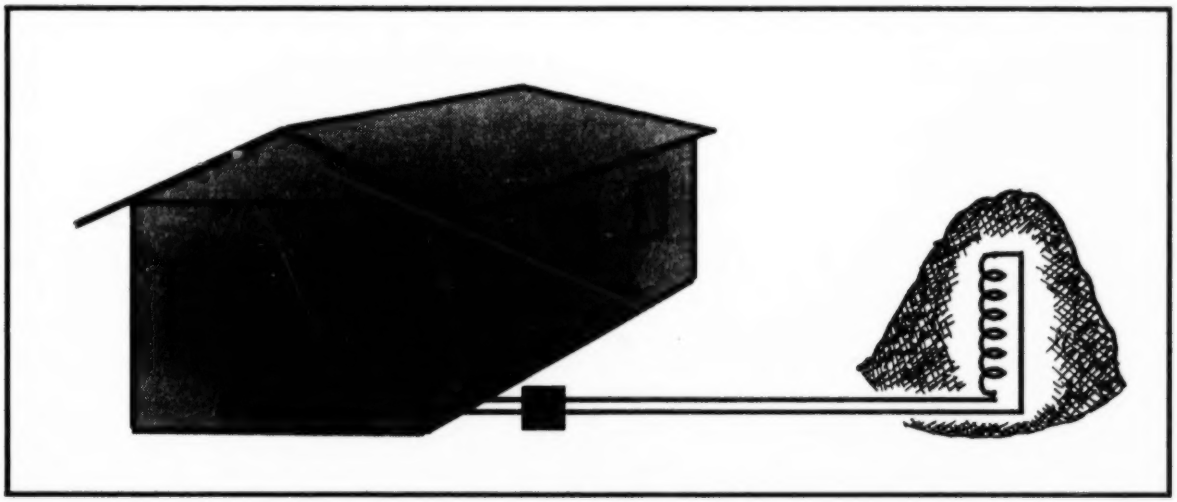
The suggested approach is to survey the attitudes of people about the problems of litter. The survey should try to establish what type of people litter and why they do so. The survey should be in schools, shopping centers, parks and other public areas and places of employment. The survey should question people's attitudes and habits towards litter disposal. The survey should also include a classification of the survey group according to age, place of residence, occupation and other factors that may be important. You may want to develop a questionnaire which would first be tested on a small group of people, revised, and then used to survey a larger sample.

REFERENCES AND RESOURCES

Consult basic college text on sampling, survey techniques and questionnaires. Ask your school guidance counselor, psychology or social studies teachers for help. Consult with your mathematics teacher for help in tabulation and analysis of the results. Make sure the sample is adequate for statistical purposes.

CREDIT Rockwell International, Columbus, Ohio

THE EFFECTIVENESS OF THE INDIRECT HEATING OF A HOUSE WITH COMPOST



BACKGROUND

Millions of years are required for the formation of fossil fuels such as oil and natural gas. Our supply of many fossil fuels, once thought unlimited, may be in sight. Much of the United States oil supply is also subject to

foreign influence, causing costs to fluctuate. Wood and coal buring stoves are again popular for home use.

PROBLEM

Determine the effectiveness of the indirect heating of a home with the energy generated in a compost pile.

METHOD AND MATERIALS

Consider using the heat produced by bacteria breaking down organic matter in a compost pile. The concept is relatively new but not as difficult as it sounds. A six inch hose is wound around the inside of the compost pile. The hose comes out the other end of the compost pile and is broken into tributary-like pipes in the house. A water pump circulates the heated water throughout the house through pipes, and then through the pile compost again. The compost pile keeps the water warm. The compost pile is constructed of organic materials.

REFERENCES

Consult back issues of Mother Earth News and Organic Gardening.

CREDIT Sean Clark, Jefferson Beautification System Junior High Science Fair, Steubenville, Ohio

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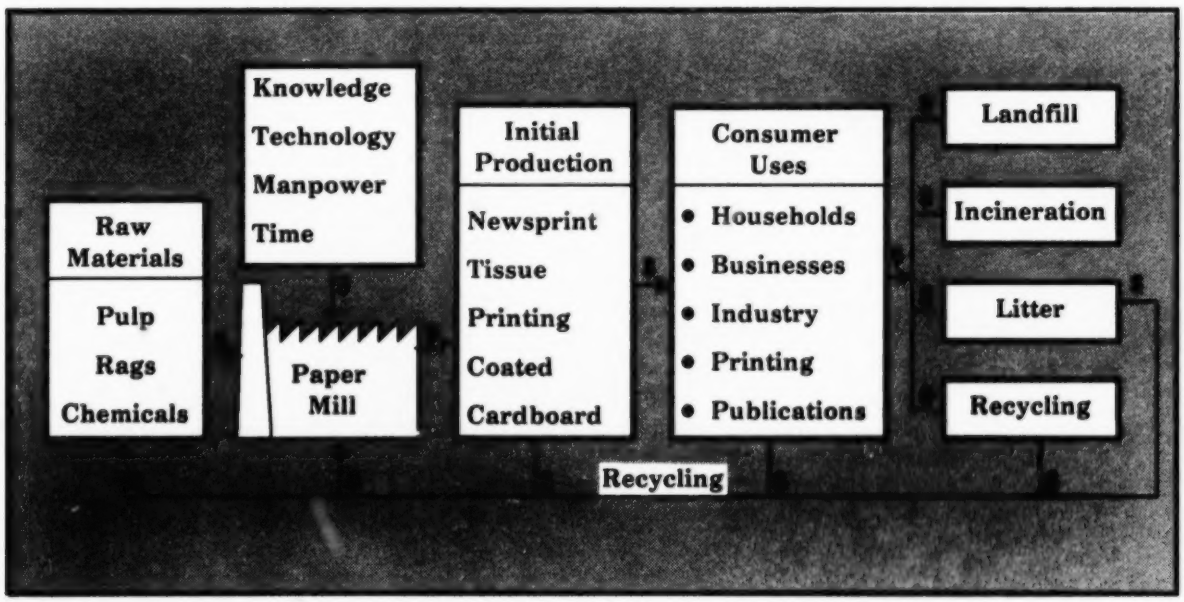
MODELING THE ECONOMICS OF PAPER RECYCLING



BACKGROUND

Recycling includes the collection and separation of such materials as glass, aluminum, and paper from trash, the processing of reclaimed materials and

the development of viable markets for the finished product. The costs associated with collection, processing, and production must be economically feasible to maintain a balance between supply and demand for the product. The case of recycled paper is particularly interesting to examine. Paper, unlike glass or metal, cannot be stockpiled while markets are developed. Additionally, waste paper must be sorted, shredded, and baled at processing facilities before being sent to paper mills. Once at the mill, paper must be decontaminated through hydropulping and de-inking prior to processing into final products such as boxboard, corrugated medium, writing paper or construction paper.

PROBLEM

Develop a graphic and mathematical model to determine the economic feasibility of recycling paper by comparing the costs associated with the production of virgin paper to those associated with the production of recycled paper. The model should include data on production costs as well as market prices for paper products and prices paid for recycled paper products. Limit your model to a segment of your community.

METHODS AND MATERIALS

For many years economists have used graphic and mathematical models to describe the economies of the world, nations and states. Basically a model is any representation of an actual system or process and may be:

- o verbal (words and descriptions)
- o physical (reduced size of real world)
- o graphic or schematic (charts, diagrams, sketch)
- o mathematical (numbers (data) and equations)

Although verbal, physical and graphic models are very helpful, mathematical models are often the most useful because they enable the researcher to predict the outcome of some action, such as reducing the labor costs of recycling.

Within your community it is possible to identify the major users of paper and paper products: schools, households, businesses including newspaper publishers, industries and local governments. Further, the sources of the paper and paper products may be identified.

Construct a graphic and mathematical model of the use of paper in your community and clearly identify the following kings of data:

- o estimated amount and value of recycled paper products in use
- o potential recycled paper products
- o estimated amount and value of non-recycled paper products in use
- o ultimate fate of all paper products (landfill, incineration, litter, recycling)
- o sources (suppliers and consumer goods) of paper products

Identify paper paper processing facilities and paper mills which deal with recycled paper. Information may be available through state offices and local chambers of commerce or by use of the Ohio Industrial Directory which is available in most local libraries.

Identify segments of your community which are potential sources of waste paper (e.g. local businesses, schools, and govermental agencies) and compare the characteristics of the waste paper with those required by the processing facilities.

Identify several markets for recycled paper products and demonstrate the feasibility of each by projecting the results in your model.

Suggest possible technical improvements which could result in a more economical process for recycling.

REFERENCES AND RESOURCES

"Smoothing the Road to Resource Recovery." Final Summary Report of the Task Force on Solid Waste, January 1986, The Partnership for New Jersey, 317 George Street, New Brunswick, NJ 08903.

Fortune, April 1, 1985 "The Sweet Smell of Profits from Trash" by Colin Leinster, pp 150-154.

Atlantic, March, 1985 "Where Will All The Garbage Go?" by J. Tevere MacFadyan, pp 29-38.

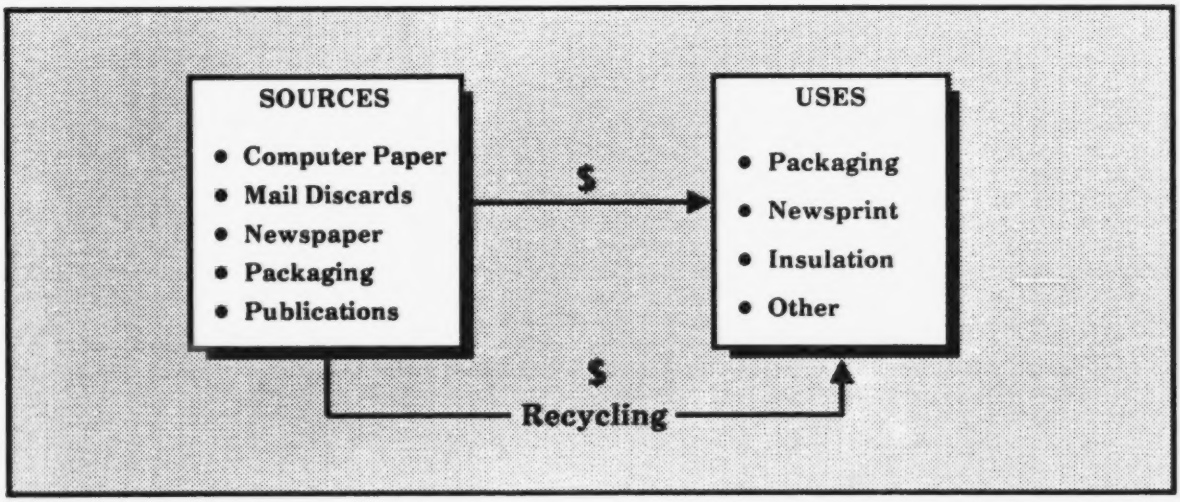
Papke, Chuck. 1985. Secondary Fiber Pulping:Current Issues from the TAPPI Conference. Resource Recycling. March/April 1985. 4(1):26-27.

Rao, D.S. 1984. Old Corrugated Containers:Genesis to Paper Machines. Resource Recycling. Secp./Oct. 1985. 3(4):20-21, 34-35.

Snider, Basil, Jr. 1986. Waste Paper, Present and Future. Waste Age 17(9):53-54.

CREDIT Modified from a idea on the economics of recycling originally submitted by Allied-Signal Inc., Columbia Road and Park Avenue, Morristown, NJ 07960.

RECYCLING OFFICE PAPER



BACKGROUND

It was estimated that in 1977 some 900,000 tons of potentially recoverable office waste paper was landfilled in the United States. By 1990, this figure is expected to rise 1.2 million tons. If recovered, this material can be recycled into printing and writing paper, and tissue and paper towel products. Recycling it not only reduces the volume of waste being landfilled, but also saves the energy equivalent of 384 gallons of oil per recovered ton in making writing paper and 462 gallons of oil per recovered ton in making tissue and towel products.

PROBLEM

Develop, demonstrate and determine the effectiveness of a white paper recycling system at the school.

METHODS AND MATERIALS

Use the model developed in the above project, or follow the methods in the above project but limit the community sector of your model to your school and consider only office paper use.

Bins to collect the paper will need to be placed in selected locations. The program will need to be publicized through such media as posters and school announcements. A local recycler will need to be contacted to arrange paper pick-up. The reduction in school waste disposal costs will need to be calculated and should be included in your model.

REFERENCE AND RESOURCES

American Paper Institute, 260 Madison Avenue, New York, NY 10016.

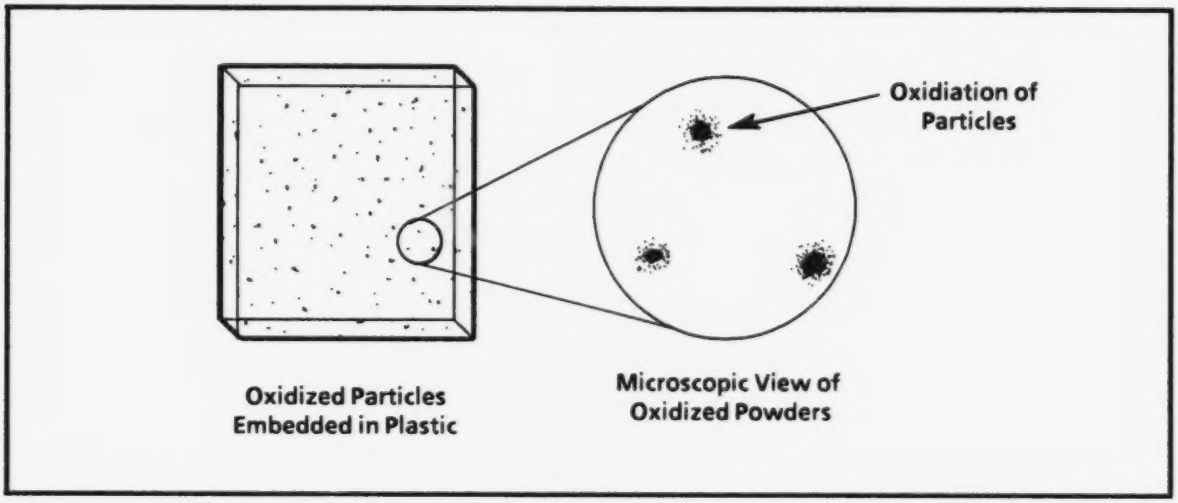
Mr. Richard Funk, State Coordinator of Victory Over Waste (VOW), Maryland Department of General Services, Room 1301, 301, West Preston Street, Baltimore, MD 21201

Keller, Richard. 1984. Office Waste Paper Recycling. Resource Recycling. May/June 1984. 3(2):18-19.

Hertzberg, Richard. 1986. Harvesting the Urban Forest. Resource Recycling. May/June 1986. 5(2):10-13, 34-35.

CREDIT Modified from an idea originally submitted by The Coca-Cola Company, One Coca-Cola Plaza, Atlanta, GA 30313.

OXIDATION OF METAL POWDERS FOR INCORPORATION IN COMPOSITE MATERIALS



BACKGROUND

Stronger brittle glass or ceramic materials can be used in more durable products which may result in the production of less waste from broken parts or discarded materials. The incorporation of small particles of a second phase non-brittle material in brittle glass or ceramic materials is frequently found to increase the "toughness" and the strength of the brittle material. Metals such as iron and aluminum are good candidate second phase materials. In order to get strong bonding between the metal particles and ceramic grains or glass (generally oxide materials), it is useful to oxidize the metal particles. Oxidizing metal particles by heating them in air is a costly process because the powders sinter ("stick") together and have to be separated by grinding after heating.

PROBLEM

Develop and test a method to produce an oxide layer with a thickness of 1-5 microns on fine iron or aluminum powders. "Fine" powders are less than 45 microns in diameter.

METHODS AND MATERIALS

Oxidation layers can be produced on iron or aluminum by exposure to water or other oxidizing liquids. The process of oxidation is accelerated by heating. The sintering of particles can be minimized by agitation.

The project goal will be achieved with a written report specifying and a demonstration showing an oxidation process which is optimum in respect to time and equipment required.

Measurements of oxide layer thickness can be made by mounting the oxidized powders in plastic, grinding and polishing the mounted powders, then observing the powders in an optical microscope. An indirect determination of oxide layer thickness can be made by determining the weight gained from oxidation and calculating the corresponding average oxide layer thickness.

REFERENCES AND RESOURCES

Oxidation of Metals - any standard high school chemistry text.

Second Phase Reinforcement of Brittle Materials - Journal of American Ceramic Society - many articles on specific examples of these materials in 1984 - 1986 volumes (This journal is available in most engineering or college science libraries). Also consult Ceramics Abstracts; see especially articles under topic of "sintering."

CREDIT Brockway, Inc.

PURCHASE OF PRODUCTS WITH RECYCLABLE PACKAGING

BACKGROUND

One of the problems in waste management is the amount of recyclables we are not aware of and are throwing away daily. We need to understand what packaging on daily household items can be recycled. Consumers may want to avoid purchasing products packaged in polyvinylchloride containers (clear, plastic-like) which do

not biodegrade and may emit toxic fumes when incinerated. From an environmental point of view, it makes sense to purchase goods in packaging that can be reused, like paper, cardboard boxes, cans and glass.

PROBLEM

Determine the amount of recyclable packaging used and compare it to the amount of packaging not recyclable for similar goods or products.

METHODS AND MATERIALS

Establish what constitutes recyclable and non-recyclable packaging. Define a limited population for sampling such as your family, your neighbors or classmates. Record what individuals purchased over one week. Determine how the items were packaged and see if alternative, recyclable packaging was available but not used. Continue for a period of time to see what is used each day that can be recycled and saved. Estimate the week's recyclables and list all items used. Where appropriate, compare unit costs for items (i.e. cost per pound or ounce) for goods with and without recyclable packaging. On the lists, mark (R) beside packages that can be recycled, (NR) non-recyclable and (B) for biodegradable - throw away. Go through the (NR) items to see if they could be purchased in other packages.

Another method is to form a weekly grocery shopping list. Follow a format similar to that above.

REFERENCES AND RESOURCES

Cavanagh, Joseph C. 1985. Packaging: Will Plasitics Dominate? Resource Recycling. May/June 1985. 4(2):14-19.

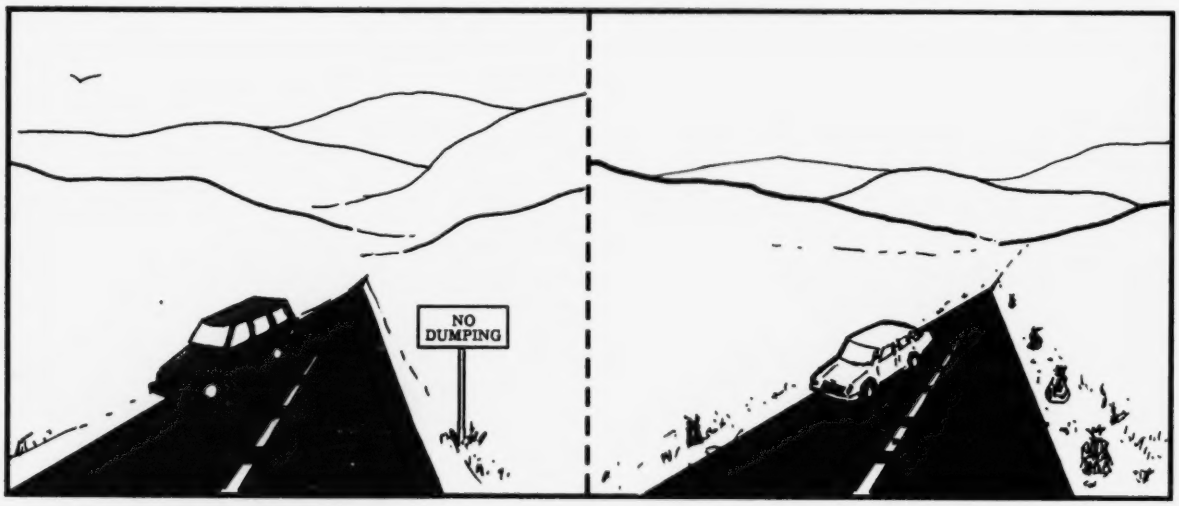
Anon. 1961. Things to do in Science and Conservation. Interstate Printers and Publishers. Danville, IL.

Simmons, Ian Gorden.1974.The Ecology of Natural Resources.Edward Arnold, London.

National Center for Resource Recovery. 1974. Resource Recovery from Municipal Solid Waste. Lexington Books, Lexington, MA.

CREDIT Lynn Holly Carine, Mahoning County Litter Prevention and Recycling Program, 940 Bears Den Road, Youngstown, Ohio 44511.

DETERMINING THE RELATIONSHIP OF LITTERING IN CLEAN VS. LITTERED AREAS



BACKGROUND

Millions of dollars are spent annually in our county to clean up litter. In our "throw away" society, we are unconsciously teaching children and others that if something is not needed anymore, throw it away. Unfortunately, many discarded items end up along our sidewalks, roadways, parks, and other public places. The accumulation of litter in certain areas compounds the problem.

PROBLEM

Determine if people throw away litter in places where litter has already started to collect.

METHODS AND MATERIALS

NOTE: If roadways are used, this project should be conducted with the permission and under the supervision of local law enforcement officials.

Set up two roadway or other sites with an equal, high volume of automobile or pedestrian traffic. Initially, both sites must be relatively free of litter. The first site will remain clean and have a "No Dumping" sign. The second area will not have a sign posted and will have two bags of trash--one closed and the other partially open. Make observations (litter counts) over a period of several weeks or months and compare the results. Keep a weekly litter diary or log book on the changes that result at both sites. Tabulate and graph your data.

REFERENCES AND RESOURCES

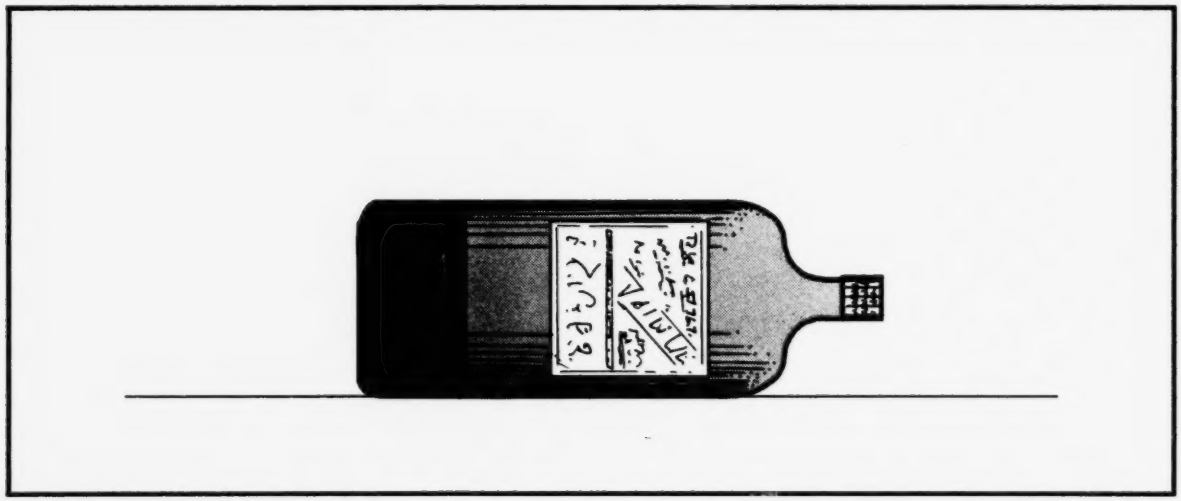
Geller, E. Scott, J. F. Witmer and M.A. Tuso. 1977. Environmental Interventions for Litter Control. J. Applied Psychology 62(3):344-351.

Miller, Christina G. and Louise A. Berry. 1986. WASTES. Franklin Watts, New York.

Shuttlesworth, Dorothy E.1972. LITTER - THE UGLY ENEMY: AN ECOLOGY STORY. Doubleday, New York.

CREDIT Montgomery County Facilities Management, Office of Litter Control, Michelle Frontani, Program Manager, Sharon McArthur, Program Assistant, 451 West Third Street, Dayton, Ohio 45422.

REUSE OF PLASTIC SOFT DRINK CONTAINERS



BACKGROUND

During 1985, approximately 4.4 billion plastic soft drink containers made of polyethylene terephthalate (PET) were sold in the United States. Only 20% of them were recovered and recycled into other products. Once the basecup (if one were attached to the bottom of the bottle), cap, and label were removed, and the remaining PET cleaned and sorted by color, about 80% of all the resulting PET was recycled into fibrefill for pillows, jackets, etc. About 5% more went into strapping to secure boxes on pallets during shipment and some material was used in the rapidly expanding engineering resin market for molded plastic parts. Yet the 20% recycle rate of PET is relatively low and needs to be increased.

The Plastic Recycling Foundation is sponsoring research to identify other end-uses for recycled PET. However, once identified, markets for these end-uses and industries to support them will require several years to develop. Recycled PET bottles are capable of holding non-food products. Therefore, if containers can be reused, they will be removed from the waste stream, achieving the same result as recycling.

PROBLEM

Identify, demonstrate and evaluate ways in which PET soft drink bottles can be reused.

METHODS AND MATERIALS

Students can collect bottles for experimentation through donation boxes placed in the school; some publicity will be necessary. Residual soft drink can be removed through rinsing. Labels may need to be removed and new paper labels applied. After identifying uses for the bottles, contacts may be required with local companies to assess their market potential.

REFERENCES AND RESOURCES

Plastic Bottle Information Bureau, 355 Lexington Avenue, New York, NY 10017, (General information and "Plastic Bottle Recycling Directory and Reference Guide 1986").

"Hunters Recycle Two-Liter Bottle into Duck Decoys," The Plastic Bottle Reporter, Vol. 3, No. 3, Summer 1985, pp. 2.

"Beverage Industry Recycling Programs," Charles Papke and Steve Rypins, Resource Recycling, November/December 1985, pp. 20-23.

"Complete Guide to Planning, Building, and Operating a Multi-Material Recycling Theme Center." Contact in writing: Ms. Gwen Cauthorne, Glass Packaging Institute, 1133 20th Street, N.W., Suite 321, Washington D.C. 20036.

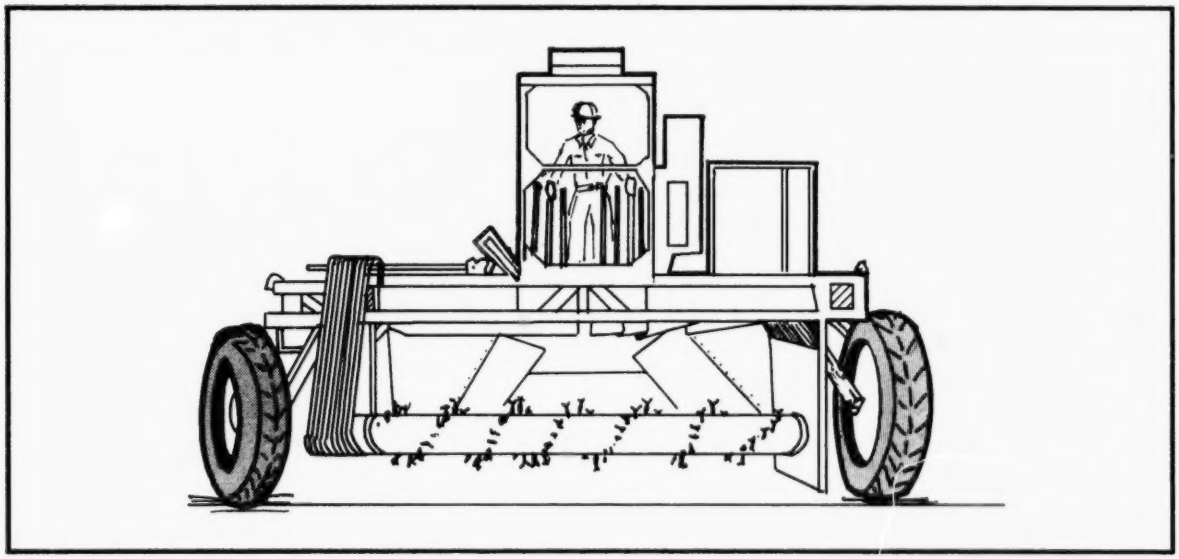
"Recycling the Plastic Beverage Bottle," Dr. Jack Milgrom, Beverage World, February 1984, pp. 57-60.

Huston, Sigrid. 1985. PET Plastics Recycling:Ryder Conference '85. Resource Recycling May/June 1985. 4(2):24-25, 53.

Bennett, R. A. 1985. PET Recycling: Today's Plastic Soda Bottle Fills Tomorrow's Ski Jacket. Waste Age 16(1):50-53.

CREDIT The Coca-Cola Company, One Coca-Cola Plaza, Atlanta, GA 30313

DEVELOPMENT AND TESTING OF A PROTOTYPE MECHANICAL ALTERNATIVE TO LABOR INTENSIVE, ROADSIDE LITTER PICKUP



BACKGROUND

In agriculture, mining and many other industries mechanical devices have been developed to reduce labor costs in the handling of materials. Such devices as combines, corn pickers, ballers, rakes, conveyors and industrial sweepers have replaced human hands to move crops, ore and other materials more efficiently. Roadside litter pickup is labor intensive, but it may be possible to apply the mechanical principles used in agriculture and mining to harvest or pick up roadside litter.

PROBLEM

Develop and test a prototype device or piece of equipment which will pick up a variety of litter types (paper, cans, bottles (including broken ones), pieces of tires and other car parts) under actual or simulated roadside terrain. Examine the economic feasibility of substituting more mechanical means for human hands.

METHODS AND MATERIALS

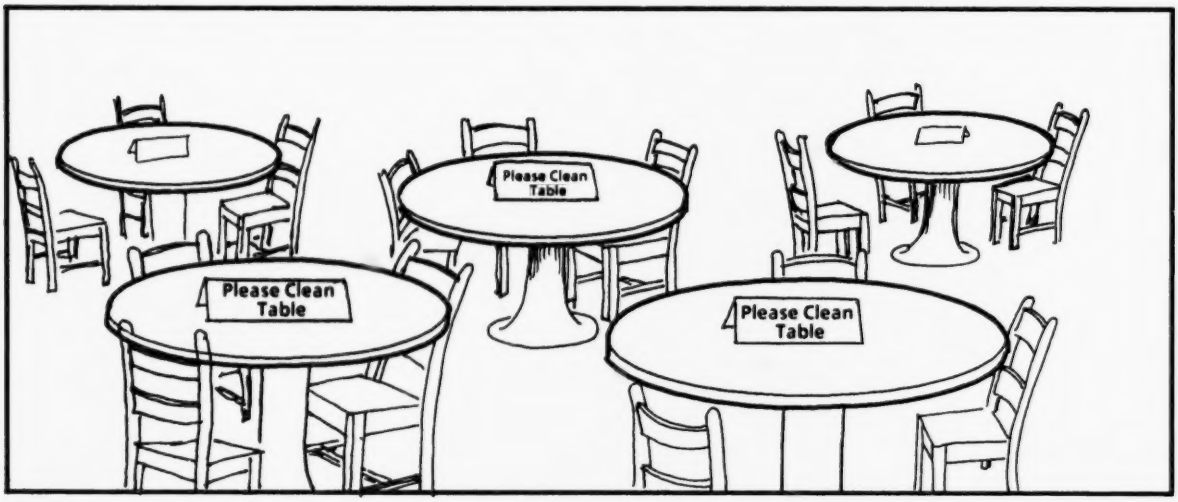
Obtain litter pickup cost information from county or city departments of transportation or local litter prevention offices. Examine the functioning of several pieces of agricultural or other industrial equipment used to handle material: combines, hay balers, rakes, augers and conveyor belts. Pay close attention to the specific mechanical means used: paddles or spring teeth, conveyor belts, chutes, blowers, separating grates or screens and augers. Determine how a current piece of used equipment could be modified to pick up litter. For example, could an old hay rake and/or baler be modifed to pickup and/or bale litter?

REFERENCES AND RESOURCES

Check with equipment manufacturers (See Standard Industrial Codes)
Seek help from industrial arts instructors or other vocational instructors.

CREDIT Lynn Edward Elfner, The Ohio Academy of Science.

PSYCHOLOGICAL PROMPTS FOR ANTI-LITTER BEHAVIOR



BACKGROUND

Several studies have shown that individuals will properly dispose of trash if prompted by specific, conveniently located messages. Clean up of restaurant tables consumes a significant portion of staff time. It is to the advantage of the restaurant to have the patrons clean their own tables and to avoid littering.

PROBLEM

Determine the effectiveness of anti-litter messages on table cards.

METHODS AND MATERIALS

Obtain permission to conduct experiment from restaurant owners or cafeteria managers. Type or neatly letter (using press-on letters) small (3" x 5" or 5" x 7") cards folded tent-like. Put a brief message such as the following on both sides of the cards: "Please Clean Table", "Please Put Trash In Proper Containers", "Thank You For Clearing Your Table." For each of several (3-5) consecutive days categorize the littering behavior of the first 25 patrons. DO NOT USE TABLE CARDS. Repeat your observations the following week with the TABLE CARDS in the middle of each table. Record the differences.

REFERENCES & RESOURCES

Geller, E. Scott, Jill F. Witmer and Andra Orebaugh. 1976. Instructions As Determinant of Paper-Disposal Behavior. Environment and Behavior 8(3)417-439.

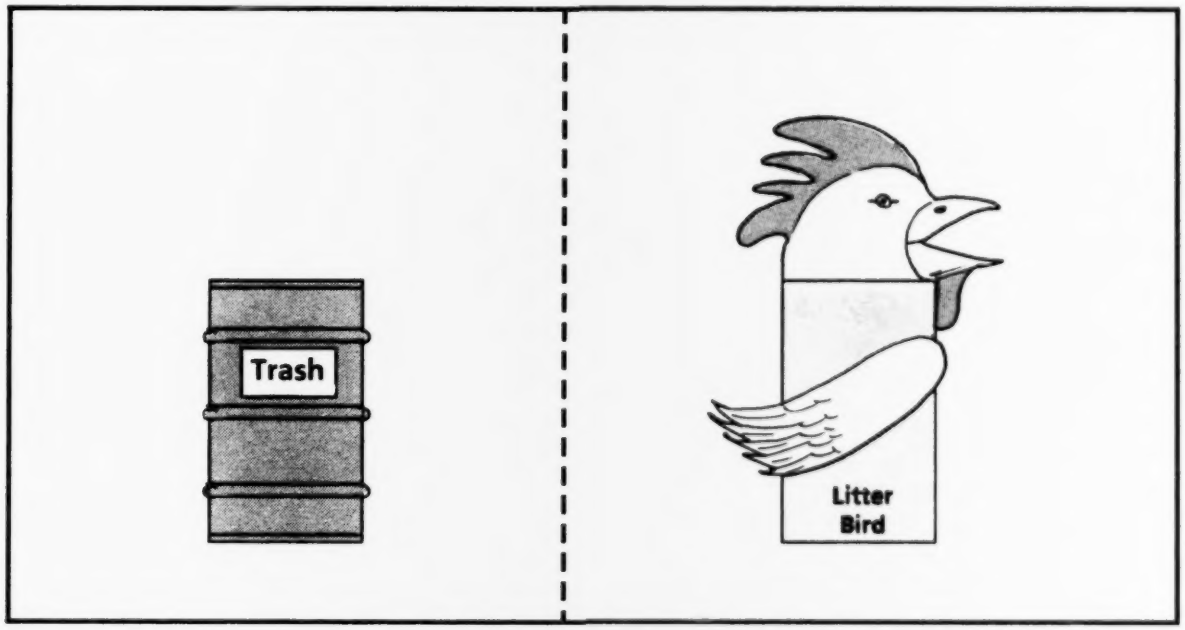
Geller, E. Scott, Jill F. Witmer, and Margaret A. Tuso. 1977. Environmental Interventions for Litter Control. J. Applied Psychology 62(3):344-351.

Reich, J. W. and J. L. Robertson. 1979. Reactance and Norm Appeal in Anti-Littering Messages. J. Applied Social Psychology 9(1):91-101.

CREDIT

Modified from an idea submitted by Dr. E. Scott Geller, Virginia Polytechnic Institute and State University.

THE EFFECT OF WASTE RECEPTACLE DESIGN ON LITTER CONTROL



BACKGROUND

Work by Dr. E. Scott Geller at the Department of Psychology of Virginia Polytechnic Institute and State University has shown that design of waste receptacles affects their use in such areas as shopping malls. A colorful bird motif waste receptacle was used more frequently than non-obtrusive designs.

PROBLEM

Determine the effect of waste receptacle design on disposal of trash in a highly travelled area such as a store, shopping mall or school.

METHODS AND MATERIALS

Obtain permission to conduct your research from store owners, mall managers or school principal. Select an area of high pedestrian traffic volume. Draw a floor plan or photograph the area so that you can locate sites for placing trash receptacles. Use at least six trash receptacles, three of which have some colorful design (shape and/or color) such as a bird or flower. Make systematic (every few hours) collection and measurements of trash in and around each of the receptacles. Establish precise locations for the containers, but every few days vary the position of the cans to determine if the location and not the design many be influencing your results. Measure trash (weight and volume) in the cans and nearby litter (misplaced trash).

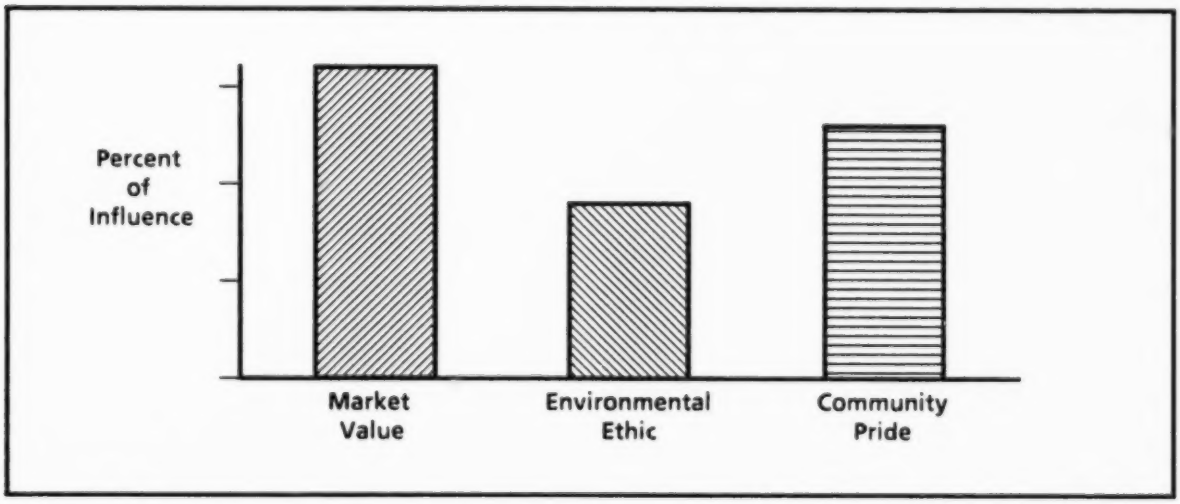
REFERENCES AND RESOURCES

Geller, E. Scott, W. S. Brasted and M. F. Mann. 1979. Waste Receptacles Designs as Interventions for Litter Control. J. Environmental Systems. Vol 9 (2). P. 145-160.

CREDIT

Modified from an idea submitted by Dr. E. Scott Geller, Virginia Polytechnic Institute and State University.

PROFILE OF BEVERAGE CAN COLLECTORS



BACKGROUND

In many communities a few consumers routinely collect beverage cans for recycling. The motivation to recycle cans may be due to several factors including the market value of the cans, access to recycling centers and the attitude of the comsumer toward environmental protection.

PROBLEM

Determine the factors most influential in motivating consumers to recycle beverage containers. If the market value is the most important factor, what is the threshold price/pound or other unit of value below which the consumer will no longer return cans for recycling? How much influence does the development of an envioronmental ethic or concern for the environment have as a motivational factor? Are there peer group pressures or values in community pride which motivate consumers to recycle beverage cans.?

METHODS AND MATERIALS

Contact your local recycling center or local environmental groups to find names of individuals willing to be interviewed. Develop and test a brief questionnaire on a small sample group of consumers before using the questionnaire on a much larger sample. Interview at least 100 or more consumers and develop a profile of the typical local beverage can collector. Base your research on individuals who actually recycle. Predict or project the impact on recycling of beverage containers, locally, if the market price would double. What would happen if the market price were cut in half?

REFERENCES AND RESOURCES

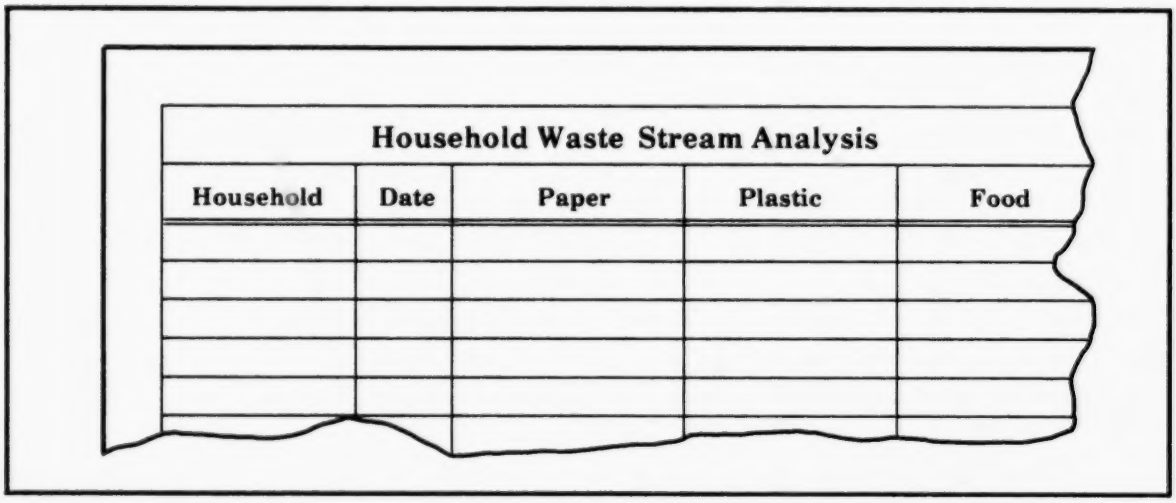
DeYoung, Raymond. 1984. Motivating People to Recycle: The Use of Incentives. Resource Recycling May/June 1984. 3(2):14-15, 42.

Papke, C. and Judy Roumpf. 1985. UBC Price Drop Affects Recovery. Resource Recycling Sept./Oct. 1985. 4(4):10-11.

CREDIT Alcoa Recycling Company Inc.

FACTORS AFFECTING THE CONTENT OF THE HOUSEHOLD SOLID WASTE STREAM

Note: Data for this could be part of a class project.



Household Waste Stream Analysis

Household	Date	Paper	Plastic	Food

BACKGROUND

The amount and content of solid waste produced varies considerably from household-to-household. Lifestyles and perhaps other factors determine the amount of wastes produced.

PROBLEM

Determine the specific factors which affect the amount and content of solid waste. Evaluate the contents of household waste in relation to lifestyles or characteristics of different households. Does the season of the year or the day of the week affect the amount and content of the waste stream?

METHODS AND MATERIALS

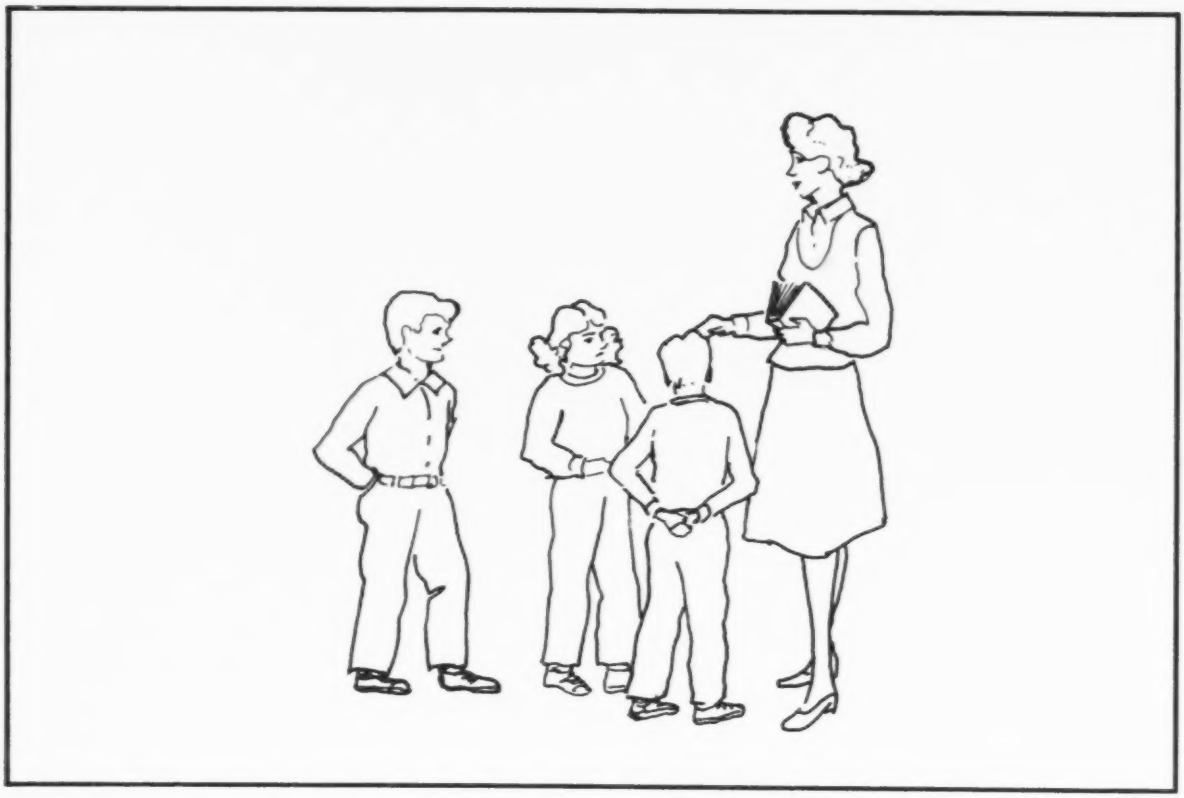
Develop and reproduce copies of a checksheet or data form listing the various potential components of the household waste stream such as paper, glass, wood, grass clippings, and food waste. Get classmates to collect data on a daily or weekly basis from the waste stream of their household. Compare the data, household-by-household, and over time to determine the factors which influence the amount and contents of the waste streams. Compare factors such as number of family members, number of meals eaten at home vs eating out, age and number of family members, amount of snack food eaten, and characteristics of the home (number of bathrooms, for example; use of garbage disposal, size of home and number of rooms).

REFERENCE AND RESOURCES

Consult back issues of Waste Age.
Child, D., G. A. Polette and H. W. Flosdorf. 1986. Waste Stream Analysis. Waste Age 17(11):183-192.

CREDIT Browning-Ferris Industries Inc.

EFFECTS OF LITTER PREVENTION AND RECYCLING EDUCATION PROGRAMS
ON STUDENTS IN GRADES 7-12



BACKGROUND

Millions of dollars are spent annually by corporations, governmental agencies and trade associations to help students and the public understand the problems and solutions to litter prevention and recycling.

PROBLEM

Evaluate the effects of an educational program of litter prevention and recycling on the knowledge and behavior of students.

METHODS AND MATERIALS

Select a limited population such as one class or one grade level. Develop a means of evaluation such as a test to be used before any educational program is introduced. Establish an education program such as speakers from local litter prevention and recycling agencies. Test the students after the introduction of the program at various time intervals such as immediately, one week, one month, several months. Determine the net results of the educational program. Basically you are seeking an answwer to the question of "Did the program make any difference in the knowledge and behavior of the students?." Seek assistance

from your teachers and from the guidance and testing office in your school. Consider using a different class, which will not receive the program as a an additional control group.

An interesting alternative to this would be to develop a test jointly with a friend in another school system. Your research colleague could repeat the experiment in the other school and share his or her data with you.

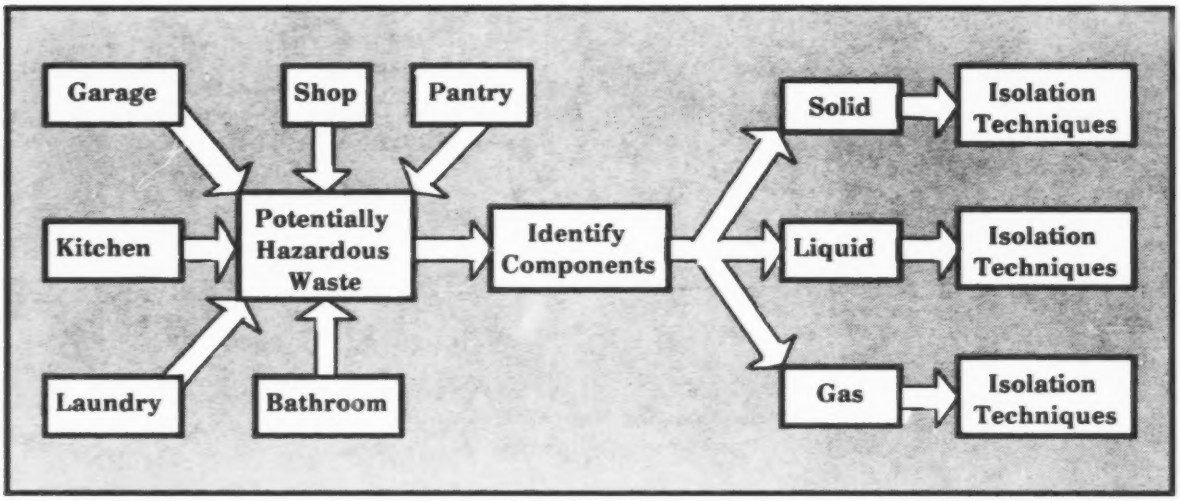
REFERENCE AND RESOURCES

Consult your school's guidance and testing office.

CREDIT Anheuser-Busch Inc., St. Louis, Missouri.

DEVELOPMENT OF A PROTOCOL OR PROCEDURE TO IDENTIFY AND ISOLATE HOUSEHOLD HAZARDOUS WASTE

Note: An alternative to this idea is to do the same thing at school or at your place of work.



BACKGROUND

Out of sight - out of mind is the attitude most people have when it comes to disposal of household waste. Once the trash service trucks make their weekly pick up, few people worry what happens next. Unfortunately, many items carelessly discarded in the weekly trash are hazardous and should not disposed of through traditional methods such as landfills and city sewage systems. Materials such as battery acids, solvents and drain cleaners should not be thrown into the garbage.

PROBLEM

Devise a protocol or procedure to enable householders to identify potentially hazardous wastes found in the home which should not be discarded in

weekly trash. Use the protocol to sample several households and predict the potential amount of hazardous waste that may be discarded.

METHODS AND MATERIALS

Inventory several homes and list all of the potentially hazardous products such as sprays, drain cleaners, motor oils and laundry products.

Develop a checklist, protocol or procedure that would enable someone not familiar with the specific hazardous nature of the product to quickly identify and isolate potentially hazardous products.

Check the product labels and list all contents. Compare contents with lists of known hazardous substances. Work with your local fire department or safety officer at local corporations to rank the various substances in terms of degree of danger or hazardousness.

Verify the hazardous effects of the products with chemical handbooks or with professionals who are familars with the products.

Determine if your community has a means of isolation, community collection and disposal or recycling of the hazardous products from households.

REFERENCE AND RESOURCES

Anon. 1985. Programs to Collect Household Hazwastes Experience a Boom. Waste Age 16(8):65-71.

Local fire department, the safety officer at a local corporation or the head of industrial hygiene at a local corporation

Ohio Industrial Commission, 246 North High Street, Columbus, OH 43215.

NIOSH (National Institute of Occupational Safety and Health)

Ohio EPA. 1986. A Guide to Safe Disposal of Household Hazardous Wastes.

Ohio EPA Public Interest Center, 361 East Broad Street, Columbus, OH 43215. Phone (614) 466-8508.

Local Poison Control Information Centers

The League of Women Voters of the United States

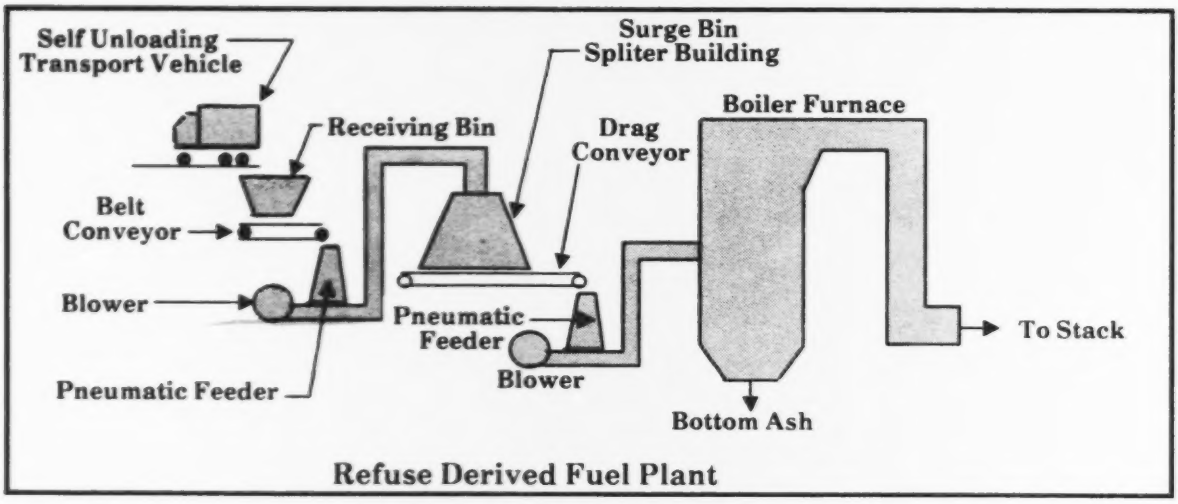
Household Hazardous Waste: Don't Bury the Problem produced by The Dow Chemical Company, Office of Public Affairs, 2020 Dow Center, Midland, MI 48674

Doherty, Maura. 1985. Household Hazardous Wastes: Seeking Safe Disposal. Resource Recycling May/June 1985. 4(2):18-21,39-40.

Galvin, David and Sally Toteff. 1986. Toxics on the Home Front. Sierra 71(5):44-48.

CREDIT International Paper Company

ENERGY CONTENT OF HOUSEHOLD SOLID WASTES



Refuse Derived Fuel Plant

BACKGROUND

Municipal solid wastes, also known as garbage or refuse, can present a challenge to all of us. The quantity of refuse generated in the USA averages to about 800-1000 pounds per person per year. It is becoming increasingly difficult to locate, and costly to develop, acceptable sites for sanitary landfilling of this material.

Because most of the components of refuse are combustible, the trend in the USA over the past 20 years has been pointed at incineration, with energy recovery. This energy recovery can be in the form of steam, electricity or both. The lack of landfill space, and the energy content of refuse offer a possible solution to this solid waste dilemma.

However, as with any burning process, efficiency can be improved if we know what we are burning. This project proposes evaluating certain materials found in household refuse, such a various types of paper, plastics, potato peelings, coffee grounds, etc.

PROBLEM

Determine the percent moisture, percent ash and heating value of the components of typical household refuse.

MATERIALS AND METHODS

The indicated analysis of the refuse components should be conducted using test procedures specified by the American Society For Testing and Materials. All of the procedures required for his project are in the ASTM Annual Book of Standards, Volume 11.04, entitled "Water and Environmental Technology".

These procedures can be carried out in a high school chemistry laboratory. The standard test methods specifically recommended for use, and included in ASTM Vol. 11.04, are:

E-711-81 Gross Calorific Value of Refuse Derived Fuel by the Bomb Calorimeter
E-790-81 Residual Moisture in a Refuse Derived Fuel Analysis Sample
E-791-81 Refuse Derived Fuel Analysis Data
E-828-81 Size of Refuse Derived Fuel From Its Sieve Analysis, Designating
E-829-81 Refuse Derived Fuel - 3 Laboratory Samples for Analysis, Preparing
E-830-81 Ash in the Analysis Sample of Refuse Derived Fuel
E-856-83 Physical and Chemical Characteristics of Refuse Derived Fuel
E-954-83 Packaging and Shipping of Laboratory Samples of Refuse Derived Fuels
E-38 Proposal P-122 Moisture and Noncombustibles of RDF-3 Macrosamples
E-38 Proposal P-123 Total Moisture (Single Stage) in RDF-3 Samples

REFFERENCES AND RESOURCES

1984 Annual Book of Standards, Volume 11.04, Water and Environmental Technology - American Society for Testing & Materials (ASTM), 1916 Race Street, Philadelphia, 19105.

Proc. - International Conference on Prepared Fuels and Resource Recovery Technology, Feb '81, U.S. Department of Energy - ANL/CNSV-TM-60, Argonne National Laboratory.

Proc. - National Waste Processing Conference - 1982 - New York American Society of Mechanical Engineers - New York, New York.

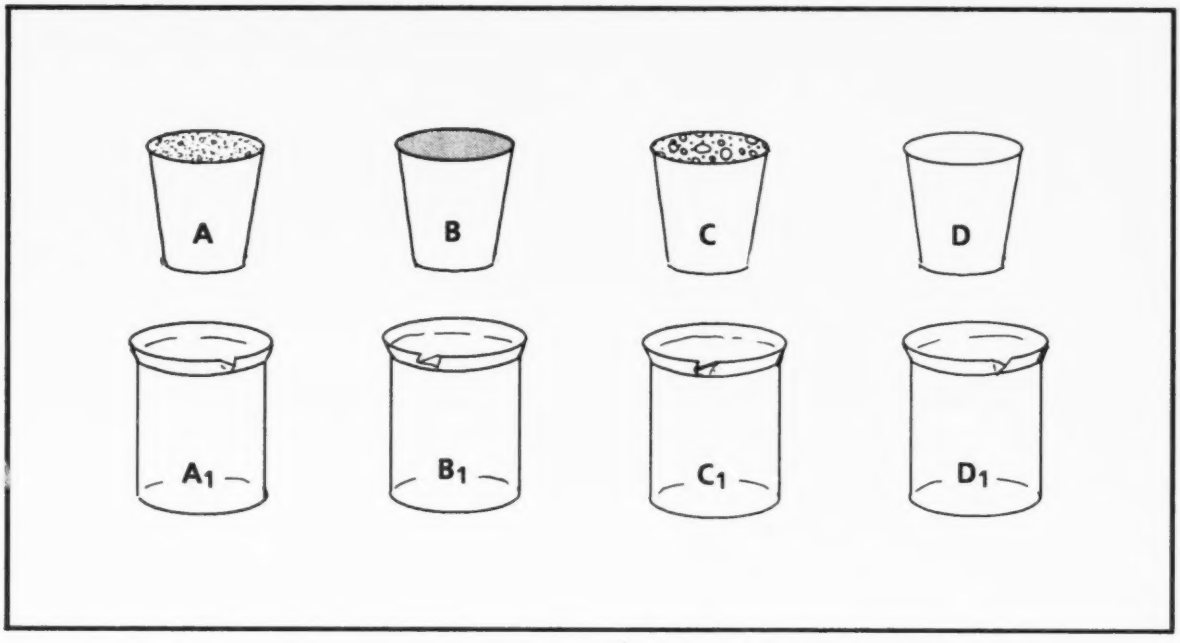
National Bureau of Standards - Speical Publication 662, 1983, Harvey Yakowitz - Editor, Washington, D. C.

A Study to Identify Opportunities for Increased Solid Waste Utilization, 1972 - Battelle Columbus Laboratories - Columbus, Ohio.

Child, D., G. A. Polette and H. W. Flosdorf. 1986. Waste Stream Analysis. Waste Age 17(11):183-192.

CREDIT Gilbert F. Bourcier, Recycling and Reclamation Division, Reynolds Metals Company.

THE EFFECTIVENESS OF DIFFERENT LANDFILL LINER MATERIALS IN CONTAINING LEACHATE GENERATED BY SOLID AND HAZARDOUS WASTES



BACKGROUND

Disposal of wastes in landfills may pose significant environmental problems if the landfill is not properly designed and constructed. When rain or surface water comes in contact with decomposing waste or hazardous waste, leachate is generated. In order to protect groundwater (water that is located underground) from potential contamination, a barrier or liner is needed at the bottom of the landfill to prevent downward migration of leachate. The most common method of preventing leachate migration is to site a landfill in a location that has very little useable groundwater and a natural clay barrier. Artificial liners manufactured from plastics have also been used in solid and hazardous waste landfills. Research is needed to determine the effectiveness of the different liner materials.

PROBLEM

Compare the effectiveness of different liner materials in attenuating leachate.

MATERIALS AND METHODS

Obtain samples of sand, gravel, clay soil and several artificial (plastic) liners. Place the liner material in a plastic cup that has been perforated on the bottom. Put a small quantity of water with food coloring added (measured amount) and compare the amount of water that has passed through the material. The time that it takes for the liquid to pass through the liner should also be measured. Care should be taken that the liquid added does not pass through the side of the cup and the liner material.

Another experiment that can be conducted is to determine the ability of several different liner materials to retain or hold hazardous substances. Common household cleaning agents and products can be used, i.e., ammonia, vinegar (or any other acid), paint thinner, gasoline, used oil. Use litmus paper or a pH meter to test the pH of the ammonia an acid and then test the liquid that passes through the liner. After paint thinner and gasoline have been poured into the liner, smell the liquid that passes through to determine if any paint thinner or gasoline has passed through the liner material. Whether used oil passes through the liner can be visually checked. The length of time for the material to pass through the liner should also be measured or observed.

Materials:

- Several hard plastic cups.
- Liner materials - gravel, sand, silt soil or potting soil, clay soil, clay, commercial plastic liner material.
- Containers to catch the liquid that passes through the liner.
- Ammonia, vinegar or acid, paint thinner, gasoline, used oil.

REFERENCES AND RESOURCES

Anon. 1986. Landfill Geotextile Guide. Waste Age 17(3):97-100.

Cadwallader, M. W. 1985. Double Liner Systems: A Review and Case Study. Waste Age 16(12:39-42.

Morrison, Allen, "Can Clay Liners Prevent Migration of Toxic Leachate", Civil Engineering, July 1981, pp. 60-63.

Schevon, G. and G. Damas. 1985. Using Double Liners in Landfill Design and Operation. Waste Age 16(9):57-64.

Landfill and Surface Impoundment Performance Evaluation, US EPA, SW-869, September 1980.

Hydrologic Simulation on Solid Waste Disposal Sites, US EPA, SW-868, September 1980.

Lining of Waste Impoundment and Disposal Facilities, US EPA, SW-870, September 1980.

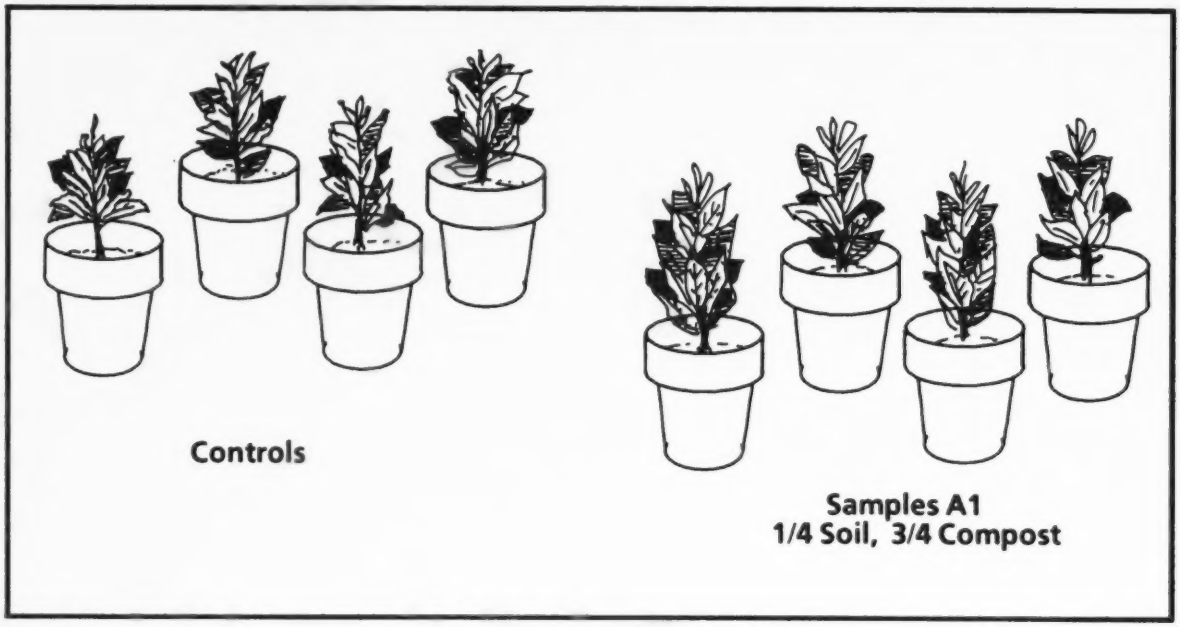
"Using Geomembranes as Landfill Liners", Waste Age, September 1982.

CREDIT

Tina Redman, Division of Solid and Hazardous Waste Management, Ohio Environmental Protection Agency, (614) 462-6358 for information concerning artificial liners.

Excerpt from: Science Day Research Ideas, Columbus Clean Community.

THE EFFECTS OF VARIOUS COMPOST MATERIALS ON PLANT GROWTH



BACKGROUND

Composting of leaves, grass clippings, sewage sludge, and solid waste is an emerging technology used to reduce the volume of wastes that would normally be disposed of in landfills. A major deterrent in developing this technology is a lack of demand for the finished compost product. A science fair project which may demonstrate the usefulness of compost as a soil conditioner will increase public awareness as to the benefits of compost.

PROBLEM

Determine the effect that several different types of finished compost products will have on plants.

MATERIALS AND METHODS

By comparing a control plant grown in a container of ordinary soil with plants grown in mixtures of soil and the four compost types, measure the growth rate and observe the overall condition of the plants. In another experiment, using one type of compost material as the growing media, grow plants in several different soil/compost ratios i.e., all compost, 1/4 soil, 3/4 compost; 1/2 soil, 1/2 compost; 1/4 compost, 3/4 soil; all soil. Measure and observe the rate of growth and overall condition of the plants.

Controls should be incorporated into your experiment and include:

1. The pots used to grow the plants should all be the same size.
2. All the plants grown should be the same type.
3. Water given to each plant and the amount of sunlight should be the same for each plant.
4. The soil used should be the same for each plant.

Materials Needed:

1. Ten Growing Pots.
2. One variety of easy growing plant seeds; and,
3. Leaf, grass clipping, sewage sludge and solid waste compost.

REFERENCES AND RESOURCES

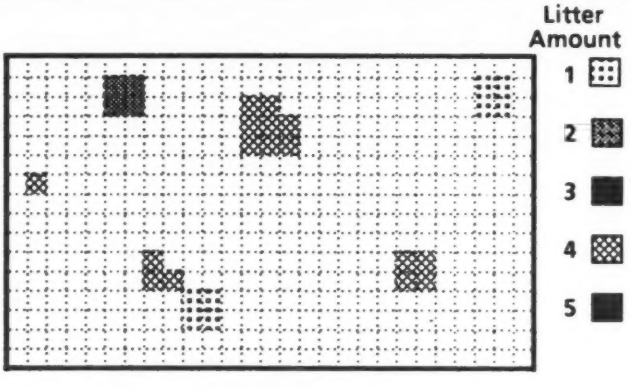
Anon. 1980. Composting: Theory and Practice for City, Industry and Farm. The J.G. Press, Emmaus, PA. 246 p.

Hirai, M.F., A. Katayama and H. Kubota. Effect of Compost Maturity on Plant Growth. BioCycle 27(4):58-61.

Consult back issues of BioCycle (formerly called Compost Science) and Organic Gardening.

CREDIT Ohio Environmental Protection Agency

LITTER BARREL PLACEMENT USING STATISTICAL GRAPHICS



City of Wickliffe Litter Grid with Areas Marked with Litter Amounts

BACKGROUND

How does a city know where to place its litter barrels? How many barrels does your community need to take care of its litter problems? How can your students get involved in your community's litter barrel plans?

PROBLEM

Using statistical graphics, determine how many litter barrels are needed and where they should be placed to be most effective in your community.

METHODS AND MATERIALS

Statistical graphics is a computer tool that combines the graphic capabilities of the personal computer with its ability to store and manipulate data and information. Many school and home computers have the ability to show graphically where a community's litter collects and therefore where litter barrels should be placed.

Students in Mr. Richard Benz's Science Seminar Class at Wickliffe High School have devised a simple program that graphically shows where the litter problem is most severe and where there is no litter in the city. The idea came from work that has been done in studies on frequency of cancer in communities near toxic waste dumps. In these studies, people were surveyed about the correlation of the incidence of cancer and proximity to hazardous waste sites.

The local office of litter prevention does annual litter surveys (Wickliffe students volunteer as surveyors each year as well,) rating areas in the city on a scale of 1-5. One having the least litter and 5 the most. Using a program written by two of the students (Tim Pool and Scott Christley,) the information from each day's survey is input into the computer program using a mouse on an Apple IIe or IIc computer. Each square on a grid represents a different location in the City of Wickliffe. A plastic overlay on the monitor screen shows the detail of city streets and shopping centers. The mouse allows each square to be filled in with "color" of increasing darkness as the litter survey indicates. The lighter squares represented no litter and the darker squares represented more litter. When the litter map is complete the most logical location for litter barrel placement is graphic and obvious. The survey information can be saved and compared with "maps" from subsequent litter surveys. The effect of your barrel placement can be studied easily in this way.

The program that was written by the Wickliffe students is a first generation version. There are still some rough spots and innovations that can be added. The most important aspect of this litter project is the problem solving nature of the project. Students can be introduced to the idea of statistical graphics without giving them a specific solution or method of how to set up their graphic model. Students that are computer literate should be encouraged to invent their own computer models. The class can be set up as an engineering firm. Some students can act as project managers and coordinate the team. Others can be responsible for the data gathering by working with local litter control agents. Still others can be the programmers. The systems approach to problem solving can be investigated with this litter barrel placement project. The team can describe what they need in the way of a program to the programmers and the data collectors can describe the survey form or devise their own.

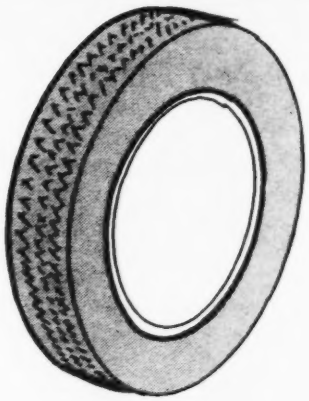
REFERENCES AND RESOURCES

Consult computer software packages.

Write to Mr. Richard D. Benz, Wickliffe High School, 2255 Rockefeller Road, Wickliffe, OH 44092.

CREDIT Richard D. Benz, Science Chairman, Wickliffe High School

ENERGY RECOVERY FROM SCRAP TIRES



BACKGROUND

Annually more than 170 million replacement tires are sold in the United States. Of the 170 million tires that are replaced, a small percentage are retreaded but the vast majority are disposed of. At present, there are billions of pounds of scrap tires in need of disposal.

Many tire disposal methods have been proposed over the last twenty years. These includes physical applications such as artificial reefs, highway abutments, asphalt components (gound rubber), erosion control, etc.; chemical methods such as reclaim, pyrolysis and biodegradation; and incineration. All of the above disposal methods have been tried and most are being used. But a surplus of scrap tires, as indicated above, still rmains for various reasons such as: high transportation costs because of bulkiness, and a lack of dumps because scrap tires are generated everywhere.

PROBLEM

Incineration, reclaim, and pyrolysis are disposal methods which recover energy from the scrap tires. Determine which of these methods of disposal: 1) recovers the most energy per pound of scrap rubber or 2) is the most economical.

REFERENCES

Apotheker, S. and E. Markstahler. Scrap Tires Fuel Cement Kilns. Resource Recycling 3(5):20-21, 40-41.

"Scrap Tire Disposal", Rubber Reviews for 1974, Vol. 47, pp. 597-624, July 1974.

Encyclopedia of Chemical Technology, Vol. 19, pp 1002-1010, John Wiley & Sons, New York.

G. Crane & E. L. Kay, Rubber Chem. Technol., 48,50 (1975) Chem. Eng., 52 (August 2, 1976).

Y. Saeki & G. Suzuki, Rubber Age, 108, 33 (February, 1976)

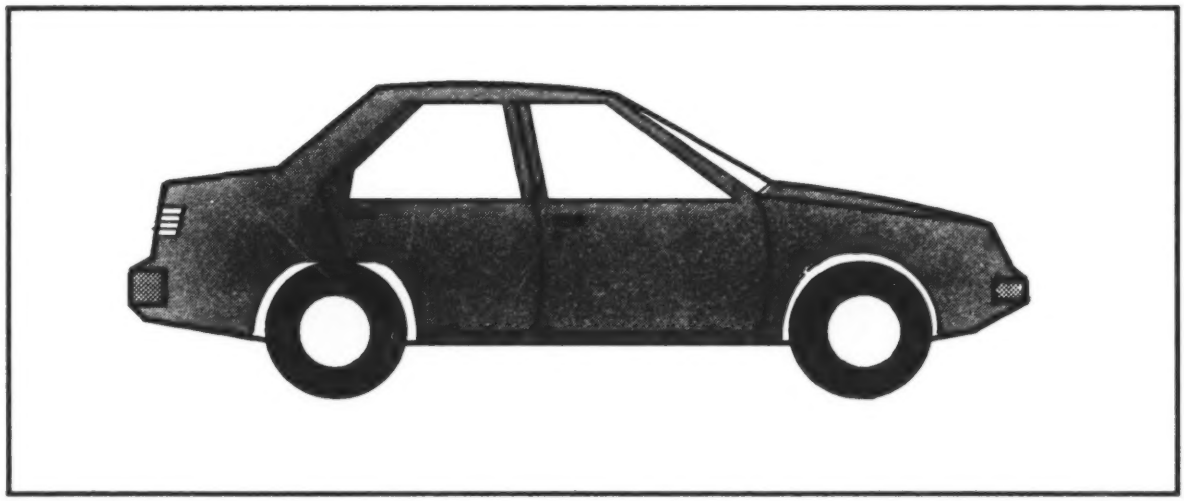
Shoemaker, D.P; Garland, C.W.; and Steinfeld, J.I. Experiments in physical chemistry. New York: McGraw-Hill, 1974. (heats of Combustion).

White, J.M. Physical chemistry laboratory experiments. Englewood Cliffs, NJ: Prentice-Hall, 1975.

CREDIT

Firestone Central Research Laboratories, 1200 Firestone Parkway, Akron, OH 44317.

DEVELOPMENT OF A PROCEDURE TO IDENTIFY AND QUANTIFY POTENTIALLY HAZARDOUS WASTES IN RECYCLABLE PRODUCTS LIKE AUTOMOBILES



BACKGROUND

Some manufacturers and fabricators add materials to their products which can be hazardous to the environment. As a result, it could be impossible to recycle metal products that contain such hazardous materials. That means more hazardous waste to dispose of -- already a real problem for our environment. One way to reduce the hazardous waste problem is to start at the very beginning by designing for recycling. Recycled metals help the environment, contribute to the economy, and save energy. If companies that manufacture products would design in recyclability by designing out hazardous materials, it could increase recycling and conserve natural resources.

With regard to potential nonrecyclability, materials today are bonded, coated, or blended in such a way that they achieve a short-term desired result

with no thought given to the effect of such actions on the recyclability of the material at some point in the future. For example, zinc coated steel clearly limits the market for the resultant scrap when it is offered for remelting. Blending of rare metals to form high-strength, low-alloy steels means that many buyers will not purchase the "contaminated" scrap that results from such steel.

Americans are being subjected to unquantifiable, but clearly major, risks directly related to the uncontrolled introduction of materials that, at the end of their service life, have the potential to become hazardous waste. Among the items involved are:

1. Cadmium is used as a protective coating on selected bolts on automobiles and as a coloring medium in household appliances.

2. Lead is in some gasoline and is used in other commercial applications. The use of lead in batteries is a major source of possible contamination.

3. Sodium azide, used to detonate air bags, is a hazardous material.

Basically, there are eight toxic heavy metals of concern: arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver. The issue is clear. Designers and engineers can no longer select and utilize materials without consideration of their recyclability and hazardous waste potential.

PROBLEM

Develop a procedure to identify and quantify potentially hazardous wastes in recyclable products like automobiles. Identify alternative or substitute materials to hazardous materials in these products.

METHODS AND MATERIALS

Obtain information on the potential toxic and hazardous effects of heavy metals like arsenic, barium, codmium, chromium, lead, mercury, selenium, an silver. Borrow repair manuals for automobiles or appliances and make an inventory of parts which may contain hazardous materials. Verify the existence of these materials by actual examination of products. Quantify your information as much as possible. Explore and describe possible substitute materials. Summarize your observations and predictions in an outline, table or graph.

REFERENCES AND RESOURCES

Anon. 1986. Design for Recycling, Phoenix Quarterly, 18(1): 8-10

Fowler, James E. 1984. Processing Automobile Hulks. Resource Recycling 3(4):14-17.

Hartman, Roy A. 1986. Product Design for Recycling. Resource Recycling 4(6):25-27.

Write to the Institute of Scrap Iron and Steel, Inc., 1627 K Street N.W., Washington, D.C. 20006.

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Development of this workbook was made possible by a grant from the Office of Litter Prevention and Recycling of the Ohio Department of Natural Resources. For your free copy write:

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